

Environmental Justice Analysis

Air Modeling Report

Prepared for

Limetree Bay Terminals, LLC

Limetree Bay Refining, LLC

St. Croix, US Virgin Islands

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June, 2019

**LIMETREE BAY TERMINALS AND REFINING
ENVIRONMENTAL JUSTICE ANALYSIS MODELING REPORT
EXECUTIVE SUMMARY**

Limetree Bay Terminals, LLC and Limetree Bay Refining, LLC (collectively, “Limetree Bay Terminals and Refining”) has submitted a permit application to EPA Region 2 to establish plant-wide applicability limitations (PALs) in accordance with 40 CFR 52.21(aa). EPA Region 2 has an obligation to address Environmental Justice (EJ) concerns during federal permitting actions. The previous owner of the refinery, HOVENSA, had performed an EJ analysis in 2004 as part of the PSD permit application for the Low Sulfur Fuels project which demonstrated that facility operations would not result in adverse or disproportionate EJ impacts. Since the 2004 EJ analysis, EPA has promulgated new National Ambient Air Quality Standards (NAAQS), including the 1-hr SO₂ and NO₂ NAAQS, and the 24-hr and annual PM_{2.5} NAAQS. Because the 1-hr SO₂, 1-hr NO₂, and PM_{2.5} NAAQS were not previously assessed in an EJ analysis, EPA Region 2 believes these new NAAQS should be assessed in an updated EJ analysis for the PAL permitting action. In order to expedite the analysis, Limetree Bay Terminals and Refining volunteered to conduct the EJ air quality analysis on behalf of and under guidance from EPA Region 2.

This document is the air modeling report for the updated EJ analysis. The modeling procedures used for this EJ analysis are generally consistent with EPA guidance set forth in EPA's "Guideline on Air Quality Models", 40 CFR Part 51 Appendix W. The latest version of EPA's preferred air quality model AERMOD was used for the air dispersion analyses, along with site specific meteorological data.

Section 10 of this report presents the results of the updated EJ modeling analysis. The maximum model predicted design concentrations (in combination with background air concentration data) are less than the 1-hr SO₂, 1-hr NO₂, and 24-hr and annual PM_{2.5} NAAQS. Therefore, the analysis demonstrates that there are no adverse air quality impacts at any location near the facility, including in any EJ areas. The locations of the highest model-predicted impacts are presented in Figures 7 through 10 of this report. These figures indicate that the maximum impacts are not disproportionately occurring in EJ communities.

In summary, this updated EJ analysis demonstrates that the air quality impacts of the Limetree Bay Terminals and Refining facility operating under the proposed PAL permit limits will not result in adverse or disproportionate EJ air quality impacts.

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1.0 INTRODUCTION

1.1 Background

Limetree Bay Terminals LLC and Limetree Bay Refining LLC (collectively, “Limetree Bay Terminals and Refining”) has submitted a permit application to EPA Region 2 to establish plant-wide applicability limitations (PALs) and issue a PAL permit in accordance with 40 CFR 52.21(aa). Note that the PAL permit request does not trigger major New Source Review (NSR) permitting requirements, including the requirement for a Prevention of Significant Deterioration (PSD) air quality analysis.

EPA Region 2 has an obligation to address Environmental Justice (EJ) concerns during federal permitting actions. Under Executive Order 12898 “Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations” (February 11, 1994), federal agencies including EPA are directed to ensure that EJ issues are addressed as part of its mission. In communities of concern, such as the areas surrounding Limetree Bay Terminals and Refining, EPA is required to perform an EJ analysis as part of the proposed federal permitting action; the EPA Environmental Appeals Board has made clear that it is a requirement.

The previous owner of the refinery, HOVENSA, had performed an EJ air quality analysis in 2004 as part of the PSD permit application for the Low Sulfur Fuels project. The HOVENSA EJ analysis was performed in accordance with the EPA Region 2 “Interim Environmental Justice Policy” document dated December, 2000, and was based on the project’s PSD air quality analysis. The EJ analysis demonstrated that the impacts of the proposed HOVENSA LSF project, in cumulative combination with other nearby and distant emission sources, would not result in adverse or disproportionate EJ air quality impacts. Therefore, there were no EJ issues associated with the LSF project permitting action.

The proposed PAL emissions are significantly less than the potential emissions of the facility as listed in the LSF PSD permit application. Therefore, model predicted air quality impacts will be lower than the impacts documented in the 2004 EJ analysis. However, since the 2004 EJ analysis, EPA has promulgated new National Ambient Air Quality Standards (NAAQS), including the 1-hr SO₂ and NO₂ NAAQS, and the 24-hr and annual PM_{2.5} NAAQS. Because the 1-hr SO₂, 1-hr NO₂, and PM_{2.5} NAAQS were not previously assessed in an EJ analysis, and because there were indicators of possible concerns regarding the 1-hr SO₂ NAAQS from the HOVENSA facility prior to idling, EPA believes these new NAAQS should be assessed in an EJ analysis for the PAL permitting action. In order to expedite the analysis, Limetree Bay Terminals and Refining volunteered to conduct the EJ air quality analysis on behalf of and under guidance from EPA Region 2.

The EJ analysis presented in this report focuses on air quality impacts, specifically with respect to the 1-hr SO₂ and NO₂ and 24-hr and annual PM_{2.5} NAAQS. Permitting actions may also cause other types of impacts to EJ communities besides air quality impacts, for example increased truck traffic impacts or effects on subsistence fishing. Because the PAL permit effectively limits air emissions and refinery operations to levels that occurred during the time period 2009-2010, this permitting action should not result in any new types of impacts in the EJ area, besides the changes in air quality impacts that result from the PAL permit limits.

This document is the air modeling report for the updated EJ analysis. Section 1 presents this introduction. Section 2 describes the dispersion model and modeling procedures used in the analysis. Section 3 describes the meteorological data and processing procedures. Section 4 describes the receptor network, and Section 5 discusses the GEP analysis and generation of building downwash parameters for the facility. Section 6 describes the NO₂ conversion methodology. Section 7 presents the background air quality data. Section 8 discusses secondary PM_{2.5} formation, and Section 9 presents the emissions and stack parameter data that were modeled. Section 10 presents the results of the analysis, which demonstrate that there are no adverse impacts at any location near the facility, including any COC areas.

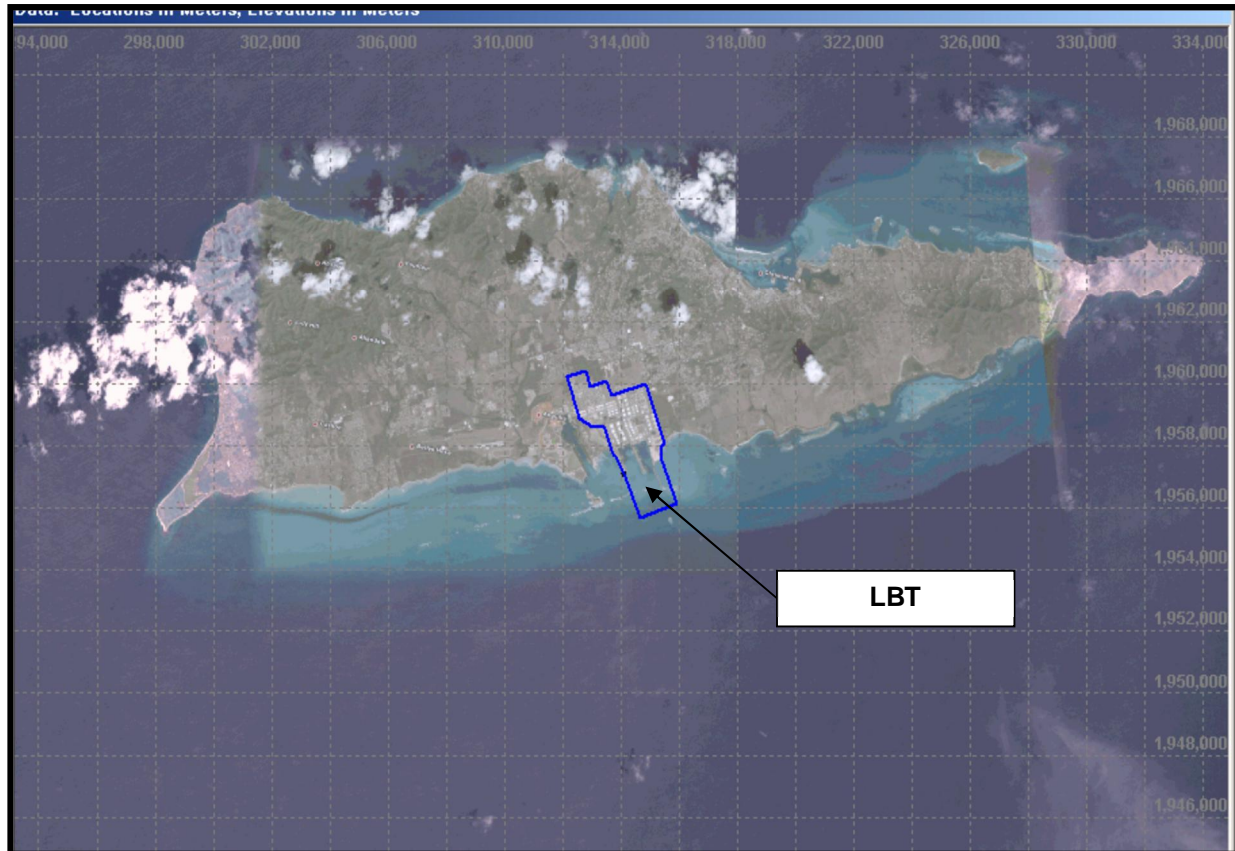
1.2 Site Description

The Limetree Bay Terminals and Refining facility is located on the southern coast of St. Croix (see Figure 1). The topography of St. Croix includes hilly terrain along the northern coastline, ranging in elevation from about 500 feet to more than 1,000 feet and topped by Mount Eagle at 1,165 feet. At the eastern end of St. Croix is another group of slightly lower hills with a maximum elevation of about 860 feet, and a third ridge of hills exists to the west and south of Christiansted (between Christiansted and the Limetree Bay Terminals and Refining site). The topography of the southern two-thirds of the island consists of a broad expanse of low hills and flat land.

1.3 EJ Analysis Procedures

The purpose of the EJ air impact analysis is to determine if minority or low-income communities (communities of concern or “COC”) bear a disproportionately high and adverse air quality impact as a result of the proposed permitting action. The air quality impact in the COC communities can be determined through actual air monitoring data, if it is available, or through an air dispersion modeling analysis. The EPA Region 2 “Interim Environmental Justice Policy” document describes the following six steps that constitute an EJ analysis:

Figure 1 – St. Croix and Limetree Bay Terminals and Refining Facility Location



NOTE: Coordinates are in meters referenced to UTM Zone 20, NAD83 projection.

1. Delineate the boundaries of the Community of Concern;
2. Compare the demographics of the community to a statistical reference;
3. Determine whether the community is either minority or low income;
4. Develop a comprehensive environmental load (ELP) profile for any community that is either minority or low income;
5. Assess whether the burden is disproportionately high and adverse; and,
6. Summarize and report the results.

For steps 1 through 3 of the previous HOVENSA EJ analysis conducted in 2004, EPA Region 2 prepared a Geographical Information Systems (GIS) analysis and map of St. Croix that identified potential COCs near the refinery based on low-income statistics from US Census data. For this updated EJ analysis, EPA Region 2 has now requested that the ELP be determined for all areas near the facility, not just the specific EJ communities. Therefore, steps 1 through 3 were not updated for the current EJ analysis.

Step 4 in the updated EJ analysis is the development of the Environmental Load Profile (ELP). In this case, the ELP is based on the model predicted air concentrations from the Limetree Bay Terminals and Refining facility, in combination with existing background air concentration data (which includes impacts from other existing sources in the area).

Step 5 in the updated EJ analysis is an evaluation of the ELP to determine if the impacts to the COC are disproportionately high and adverse. The air dispersion model predicted impacts will be compared to the 1-hr SO₂, 1-hr NO₂, and 24-hr and annual PM_{2.5} NAAQS. If the predicted impacts are less than the NAAQS, then the analysis demonstrates that there are no adverse impacts at any location near the facility, including any COC areas.

2.0 MODELING PROCEDURES

EPA guidance for performing air quality analyses is set forth in EPA's "Guideline on Air Quality Models", 40 CFR Part 51 Appendix W (herein referred to as Appendix W). The modeling procedures used for this EJ analysis are generally consistent with Appendix W guidance.

The latest version of EPA's preferred air quality model AERMOD will be used for the air dispersion analyses. AERMOD is a steady-state plume dispersion model that simulates transport and dispersion from multiple point, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. AERMOD uses Gaussian distributions in the vertical and horizontal for stable conditions, and in the horizontal for convective conditions; the vertical distribution for convective conditions is based on a bi-Gaussian probability density

function of the vertical velocity. For elevated terrain AERMOD incorporates the concept of the critical dividing streamline height, in which flow below this height remains horizontal, and flow above this height tends to rise up and over terrain. AERMOD also uses the advanced PRIME algorithm to account for building wake effects. AERMOD will be run using default rural dispersion coefficients for this analysis.

AERMOD is designed to operate in concert with two pre-processors. AERMET processes meteorological data for input to AERMOD, and AERMAP processes terrain elevation data and generates receptor information for input to AERMOD. The latest versions of AERMET and AERMAP will be used for the air analyses.

Air modeling analyses are typically conducted in two steps: a “project-only” significant impact analysis, and if required a cumulative impact or “full” analysis. The significant impact analysis first estimates ambient impacts resulting from emissions from only the proposed Project, and only for those pollutants with Project emission increases above the PSD Significant Emission Rates (SERs). For the requested PAL permit, none of the Project emission increases exceed the SERs, and no dispersion modeling is required under the NSR regulations. However, Limetree Bay Terminals and Refining has conducted a full cumulative analysis to support the EJ analysis.

3.0 AERMET DATA PROCESSING

Appendix W states that a minimum of 5 years of representative National Weather Service (NWS) meteorological data or one year of site-specific data should be used with refined air quality models. Limetree Bay Terminals and Refining will use a five year site-specific meteorological data set from 2005-2009 for the modeling analyses. The meteorological data from 2005 to 2009 remains representative of current conditions at the refinery as there is not a significant amount of year-to-year variability in the typical trade wind and temperature conditions in the Caribbean. The following sections summarize the meteorological data bases and AERMET processing.

3.1 NWS Surface Data

Henry E. Rholsen airport data will be used as the NWS surface station. This NWS monitoring station is an ASOS station (Station #11624). It is located approximately 2.5 kilometers to the west of the refinery at 17°42' N / 64°48' W. The NWS station is representative of meteorological conditions at the Limetree Bay Terminals and Refining refinery, given the close proximity and similar environment as the refinery. The NWS data is used only for cloud cover data (the site-specific meteorological data is the source for wind speed, direction, and ambient temperature data). Based on the AERMET quality assurance audit report, greater than 90 percent of the NWS data parameters met AERMET audit criteria as shown in Table 1.

Table 1 – NWS Data AERMET Audit Report

**** SUMMARY OF THE QA AUDIT ****								
		-----VIOLATION SUMMARY-----				-----TEST VALUES-----		
	TOTAL	#	LOWER	UPPER	%	MISSING	LOWER	UPPER
	# OBS	MISSING	BOUND	BOUND	ACCEPTED	FLAG	BOUND	BOUND
CLHT	41330	414	0	0	99.00	999.0,	0.0,	300.0
AL	41330	41330	0	0	0.00	9.0,	0.0,	7.0
C1	41330	41330	0	0	0.00	999.0,	0.0,	300.0
AL	41330	0	0	0	100.00	9.0,	0.0,	7.0
C2	41330	0	0	0	100.00	999.0,	0.0,	300.0
HZVS	41330	65	0	0	99.84	99999.0,	0.0,	1640.0
TMPD	41330	980	7	3	97.60	999.0,	-300.0,	400.0
DPTP	41330	1110	0	0	97.31	999.0,	-650.0,	350.0
WDIR	41330	704	0	0	98.30	999.0,	0.0,	36.0
WSPD	41330	449	0	0	98.91	999.0,	0.0,	500.0

3.2 Upper Air Data

AERMET requires the morning upper air sounding to estimate the potential temperature gradient above the mixed layer. The nearest upper air station to the project site is the San Juan Puerto Rico station (Station #11641), located at 18°26' N / 66°01' W at an elevation of 9 feet amsl. Radiosonde data were acquired for the time period from January 2005 through December 2009 in FSL format, and processed by AERMET.

Based on the AERMET quality assurance audit report, greater than 99 percent of the upper air temperature data up to an altitude of 4000 meters met the AERMET audit criteria and were accepted for further processing.

3.3 Site-Specific Meteorological Data

Site-specific wind speed and direction at 10 meters above ground level, and temperature data at 2 meters above ground level, was collected by HOVENSA during the 2005 to 2009 time period. The meteorological monitoring program was designed to meet all relevant EPA requirements in “Meteorological Monitoring Guidance for Regulatory Modeling Applications” EPA-454/R-99-005, February 2000. The 10-meter tower site is located within 1.5 kilometers of the refinery and within 1.5 kilometers of the shoreline. The terrain towards the east is relatively flat and unobstructed (note that the easterly trade winds are very predominate at St. Croix). The base elevation of the 10-meter tower is 31 m above median sea level. Given the close proximity of the 10-meter tower site to the emission sources, the similar topographical features, and the similar influence of the prevailing trade winds, it was previously determined by EPA that the 10-meter tower collects representative site-specific meteorological data for the refinery.

For the period January 2005 through December 2009, all Data Quality Objectives (DQOs) listed in HOVENSA’s “Quality Assurance Project Plan - Meteorological Measurements, Revision 1, September 2009”, including data capture rates and semi-annual audit criteria, were met. The AERMET audit report results are presented in Table 2, which also indicate high data capture and acceptance rates.

Table 2 – Site Specific Data AERMET Audit Report

**** SUMMARY OF THE QA AUDIT ****								
SITE VECTORS	-----VIOLATION SUMMARY-----					-----TEST VALUES-----		
	TOTAL # OBS	# MISSING	LOWER BOUND	UPPER BOUND	% ACCEPTED	MISSING FLAG	LOWER BOUND	UPPER BOUND
2.00 M								
TT	43824	433	0	0	99.01	999.0,	-30.0,	40.0
10.00 M								
WD	43824	426	0	0	99.03	999.0,	0.0,	360.0
WS	43824	426	0	0	99.03	999.0,	0.0,	50.0

3.4 Site Surface Characteristics

The final stage of AERMET processing (referred to as Stage 3) reads the merged NWS surface, upper air, and site-specific meteorological data files and uses site-specific parameters that characterize the underlying surface to produce two files for AERMOD. The first file contains boundary layer scaling parameters (such as surface friction velocity, mixing height, and Monin-Obukhov length) along with reference-height wind and temperature data. The second file contains one or more levels (profile) of winds, temperature, and the standard deviation of the fluctuating components of the wind.

For Stage 3 processing, AERMET requires input of surface characteristics at the meteorological tower location including surface roughness (Z_0), Bowen ratio, and albedo by season or month. EPA has developed a tool called AERSURFACE that can be used as an aid in determining surface characteristic values for input to AERMET. However, the land use data that is used as input to AERSURFACE do not exist for the US Virgin Islands (for any of the 1992, 2001, 2006, and 2011 land use data sets). Therefore, AERSURFACE cannot be used for the proposed analysis. Instead, the AERSURFACE Users Guide presents information on surface characteristic values for surface roughness, Bowen ratio and albedo as a function of land cover categories and season, and this data will be used to perform manual calculations with the EPA recommended methodologies described above.

The “AERMOD Implementation Guide”, revised 2018, recommends that surface characteristics be determined as follows:

- The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover; however, the sector widths should be no smaller than 30 degrees.
- The determination of the Bowen ratio should be based on a simple un-weighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10km by 10km region centered on the measurement site.
- The determination of the albedo should be based on a simple un-weighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for the Bowen ratio.

Since St. Croix is located in a tropical setting, the monthly and seasonal variations in climatology and vegetation characteristics are not significant. There is a small variation in the ambient temperature in the Virgin Islands from the coolest to the warmest months, ranging about 7° F. During the warmest months of July and August, maximum temperatures average in the upper 80s °F, with nighttime temperatures falling to the mid 70's °F. During the cooler months of January and February, daily maximum temperatures are generally in the low 80s and nighttime minima in the high 60s or low 70s. Rainfall in the Virgin Islands falls most frequently in the form of brief showers, and there is no sharply defined wet or dry season. Because there is little variability in climate (and therefore vegetation characteristics) by season in the Virgin Islands, the use of annual average surface characteristics is appropriate. The annual surface characteristics will be based on the summer, non-arid season data in Table A-3 of the AERSURFACE Users Guide.

Because the forested hills in the vicinity of the Limetree Bay Terminals and Refining facility are not the typical “deciduous forest” common in the continental US, the previous LSF AERMET processing used more appropriate surface roughness characteristics for the forested areas near the refinery, based upon a review of data in “An Introduction to Boundary Layer Meteorology,” R.B. Stull, 1988 and other studies referenced by Stull. A surface roughness value of 0.6 meters was used for the forested areas near the Limetree Bay Terminals and Refining facility, with albedo and Bowen ratios taken from the AERMET users guide for deciduous forest summer average moisture conditions.

The surface roughness analysis was performed using the area defined by a one kilometer radius around the on-site meteorological monitoring station at Estate Cottage. The types of land surrounding the on-site meteorological monitoring tower consist primarily of low density residential areas, forested hills, and industrial areas. Figure 2 presents a diagram of the land use

within one kilometer of the on-site monitoring station. Figure 3 presents the 10 km by 10 km area used for the Bowen ratio and albedo analyses (centered on the on-site station).

For the on-site monitoring station, the following sectors were defined for AERMET processing (all degrees are relative to true north, with zero (0) degrees representing north, 90 degrees east, etc.):

- Sector 1 from 60 to 105 degrees, with 88% of the area being a low density residential area and 12% being an industrial area,
- Sector 2 from 105 to 260 degrees, with 83% of the area being an industrial area and 17% being a low density residential area,
- Sector 3 from 260 to 320 degrees, with 75% of the area being forested and 25% being a low density residential area, and
- Sector 4 from 320 degrees to 60 degrees, with 76% of the area being a low density residential area and 24% being forested.

The 10 km by 10 km area used for the Bowen ratio and albedo characteristics included the following surface categories: 36% water, 35% grassland/shrub land, 12% low density residential, 10% industrial, and 8% forested.

Appendix A presents the surface roughness, Bowen ratio, and albedo geometric mean calculations for the on-site meteorological monitoring station, along with the final surface characteristics that will be used in the AERMET stage 3 processing. These same calculations were previously approved by EPA as part of the HOVENSA LSF Project PSD permitting.

Note that there have not been any significant land use changes in the area surrounding the on-site meteorological monitoring station since 2004. In addition, the surface roughness, albedo, and Bowen ratio values do not need to be updated or changed, as they are based on current EPA AERSCREEN recommended values.

Figure 2 – Map of Surface Characteristics at the On-Site Meteorological Station

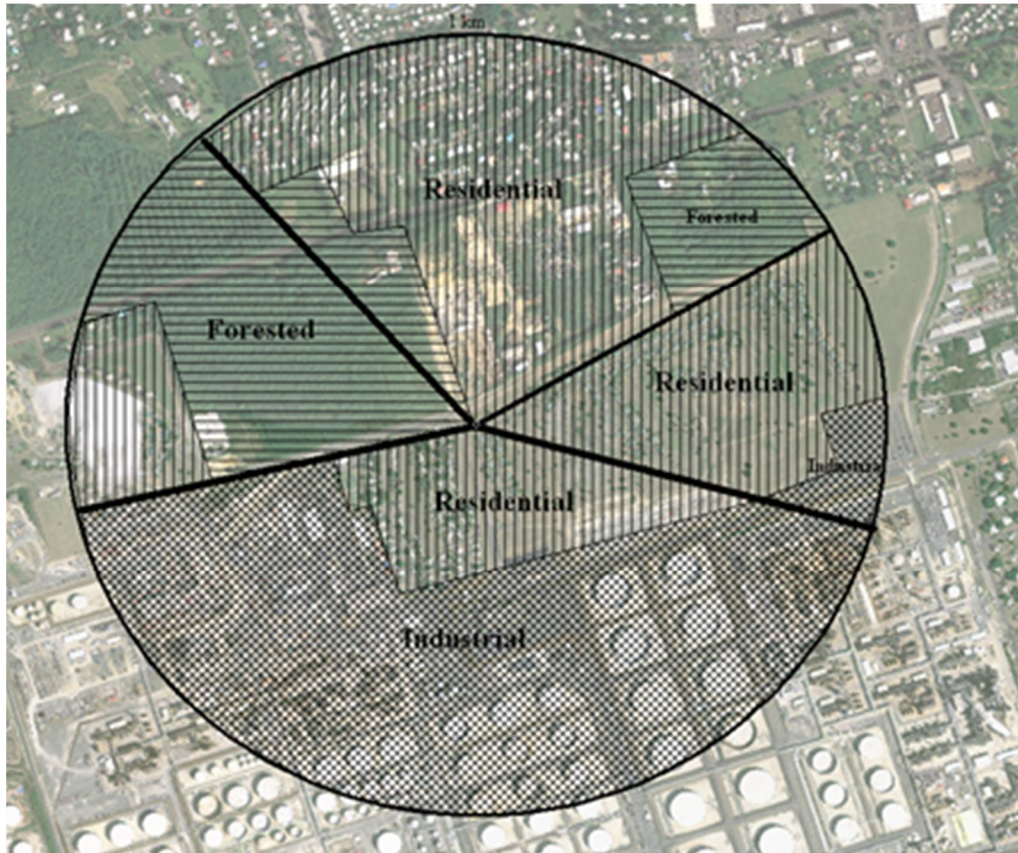
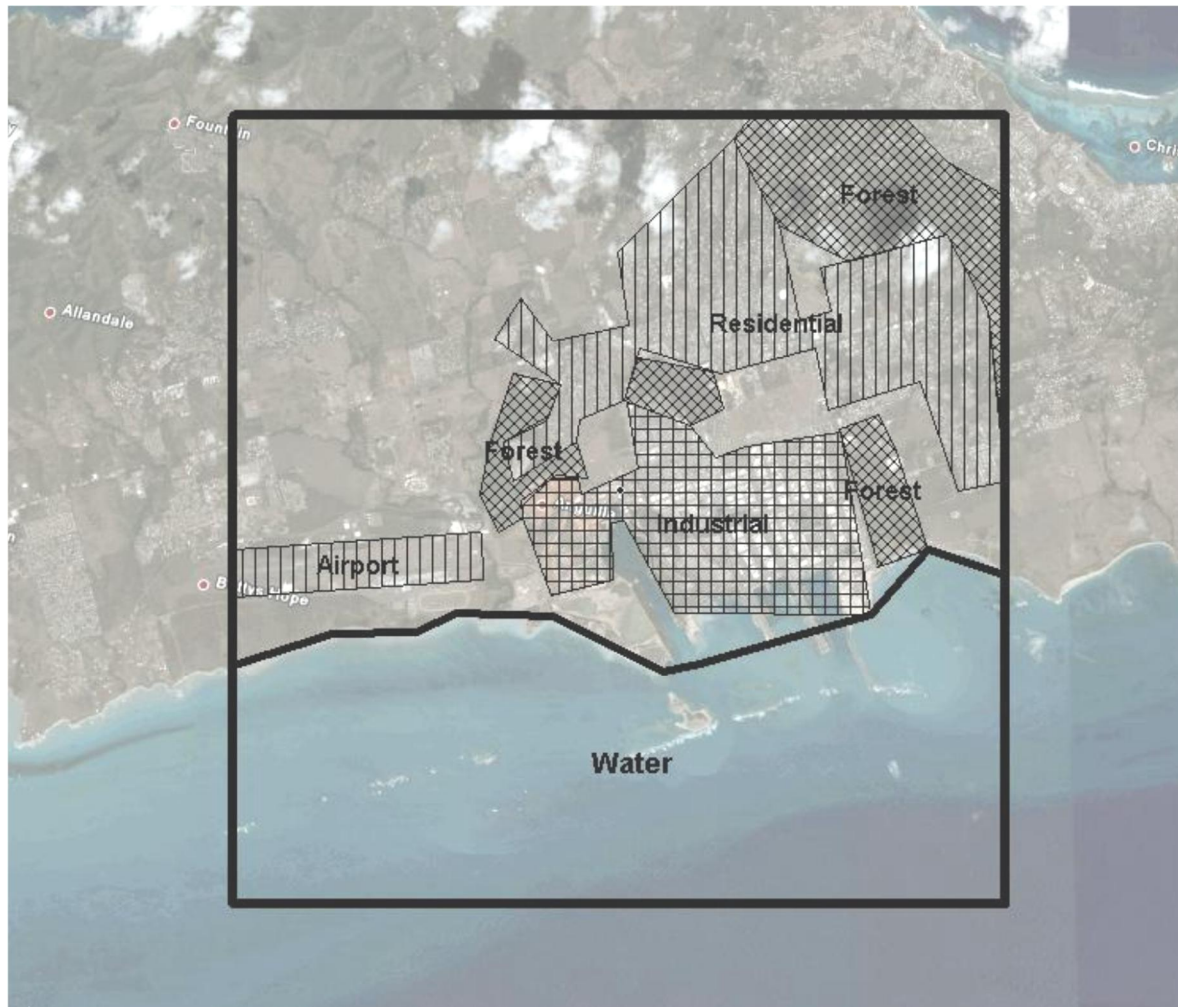


Figure 3 – Map of Bowen Ratio and Albedo Land Use Areas



NOTE: All unmarked land areas within the 10 by 10 km box are considered shrub land areas.

3.5 AERMET Stage 3 Processing

The AERMET Stage 3 processing utilized the Adjusted u^* option (note that the onsite data does not include turbulence measurements). The onsite wind data was processed using a threshold wind speed setting of 0.4 m/s (the wind data was collected using a RM Young Wind Monitor AQ sensor, with a threshold wind speed of 0.4 m/s). NWS data was not substituted for missing onsite wind or temperature data.

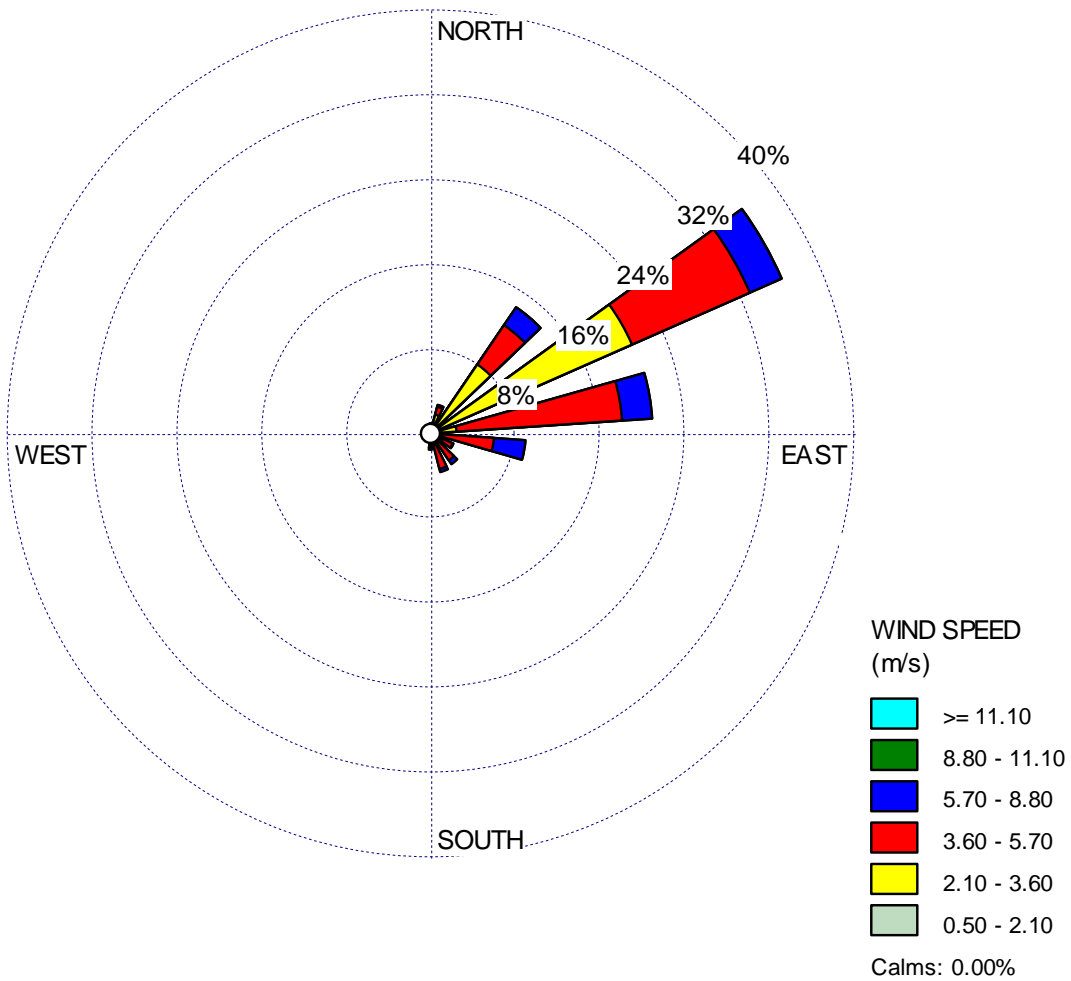
After the Stage 3 AERMET processing, the five years of meteorological data were input to AERMOD. The AERMOD run listings report the final missing data rates (which should be less than 10%). These final meteorological data statistics are presented in Table 3, and indicate that the meteorological data meets Appendix W requirements.

Table 3 – Meteorological Missing Data Rates (%)

Year	Missing Data %
2005	1.4
2006	8.5
2007	4.1
2008	6.2
2009	7.1

Figure 4 presents the wind rose for the AERMET final data for the five year period 2005-2009. The wind rose illustrates that the trade winds dominate the wind flow patterns in the area (note that the wind roses for the NWS airport data show the same predominance of the trade wind directions).

Figure 4 – Wind Rose of AERMET Data for 2005-2009



4.0 RECEPTOR NETWORK AND AERMAP PROCESSING

The selection of appropriate receptor locations is an important aspect of air dispersion analysis. Limetree Bay Terminals and Refining originally proposed to restrict receptor placement to COC areas for this updated EJ analysis. However, EPA requested that receptors be located in all areas outside of Limetree Bay Terminals and Refining fence line boundaries, and the final receptor grids comply with EPA's request. The Limetree Bay Terminals and Refining ambient air boundary is defined by security fences on land, and the patrolled Coast Guard security zone¹ on water, both of which exclude public access. The Limetree Bay Terminals and Refining fenced property boundary has been updated to reflect current property holdings.

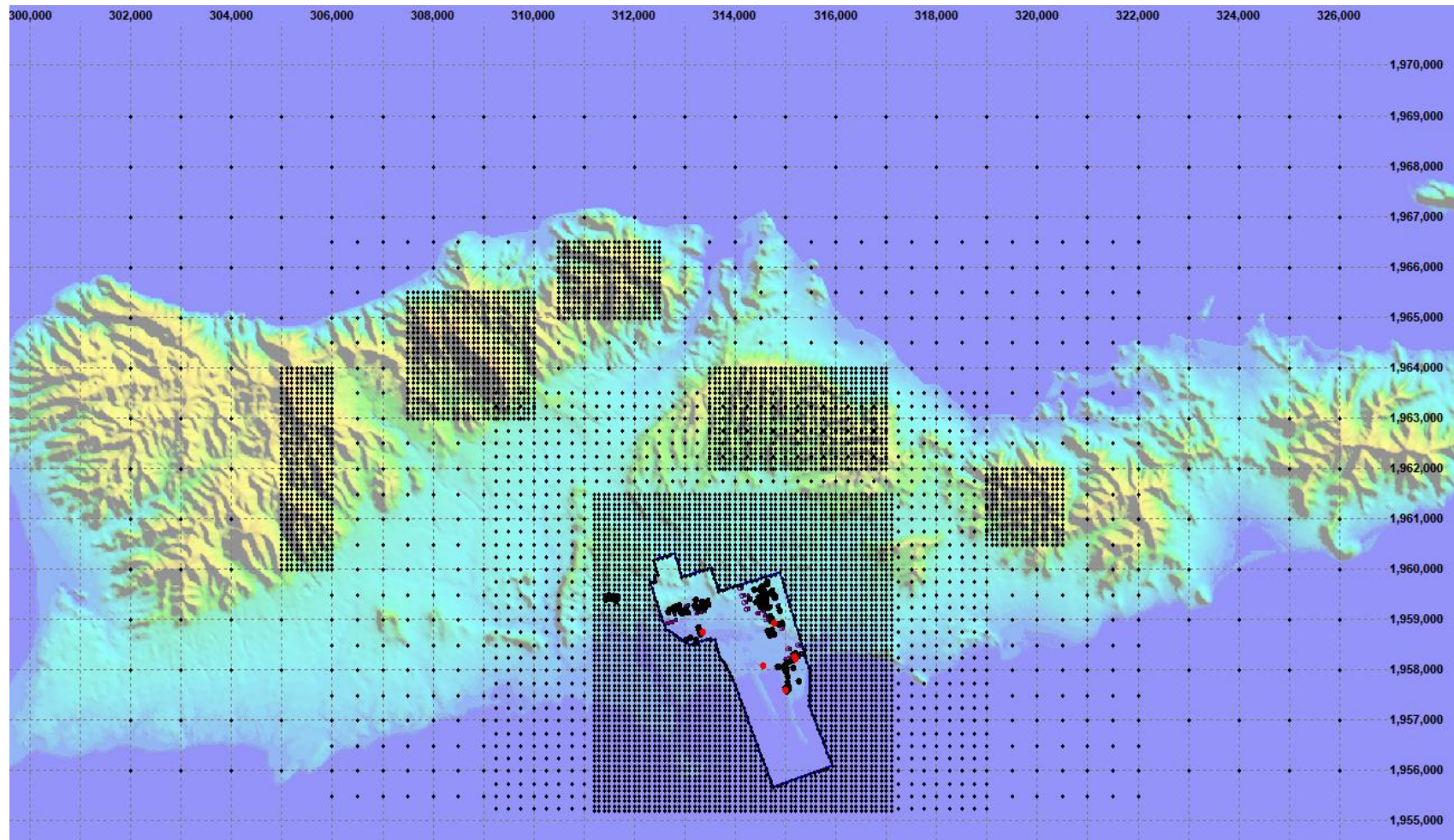
The receptor grids were developed using AERMAP, the terrain preprocessor for AERMOD. The Cartesian grids were created from USGS National elevation Data (NED) 1 second data files. The receptors developed for the Project are based on multiple rectangular receptor arrays, which decrease in density as the distance from the source increases. See Figure 5 for a plot of the receptor grids. Additional "fine" receptor grids with 100 meter spacing were created to cover elevated terrain features to the west and north of the Limetree Bay Terminals and Refining facility. The main receptor grid was based on the following spacing, and the grid was focused on covering St. Croix Island, along with a buffer area of over water receptors:

- a fence line grid at 100 meter spacing and 1100 meters deep,
- a 250 meter spaced rectangular grid extending out 2 km,
- a 500 meter spaced rectangular grid extending out 6 km,
- a 1 km spaced rectangular grid extending out 10 km, and
- 100 meter spaced grids at significant elevated terrain features.

As is discussed later in this report, for the 1-hr NO₂ NAAQS analysis the emission units at the Diageo distillery were included in the modeling. Therefore, for the 1-hr NO₂ modeling the receptors located on Diageo property were removed from the main receptor grid. A separate model run using receptors on Diageo property grid and only Limetree Bay Terminals and Refining emissions was performed to ensure maximum 1-hr NO₂ impacts were determined.

¹ On May 14, 2008, the Department of Homeland Security published a final rule (73 *Fed. Reg.* 27745) that updated the Coast Guard security zone. The final rule makes changes to the boundary established by an earlier interim rule. The security zone includes all waters surrounded by a line connecting the following coordinates: 17°41'31" N, 64° 45'09" W; 17° 39'36" N, 64° 44'12" W; 17° 40'00" N, 64° 43'36" W; 17° 41'48" N, 64° 44'25" W, and then tracing the shoreline along the water's edge to the point of origin. The security zone includes the waters extending approximately 2 miles seaward of the Limetree Bay Terminals and Refining facility including Limetree Bay Channel and portions of Limetree Bay.

Figure 5 – Updated Receptor Grid



5.0 GEP AND BPIP ANALYSES

A Good Engineering Practice (GEP) stack height analysis will be conducted as part of the air quality analysis. The latest version of EPA's BPIP-PRIME program will be used to calculate GEP stack heights that will be compared to actual stack heights to demonstrate compliance with the stack height regulations (as codified at 40 CFR Part 51). If the GEP analysis indicates that a stack height is less than the GEP height, an analysis of building downwash and wake effects will be conducted.

GEP stack height is defined as the greater of 65 meters as measured from the base of the stack, or the stack height as determined from the following formula:

$$H_g = H_b + 1.5L$$

where:

H_g = the GEP stack height,

H_b = the height of the nearby structure, and

L = the lesser dimension (height or projected width) of the nearby structure.

For a structure having a projected width greater than its height (i.e., a squat structure), the formula reduces to $H_g = 2.5H_b$. Both the height and width of the structure are determined from the frontal area of the structure projected onto a plane perpendicular to the direction of the wind. In all instances, the GEP stack height is based on the plane projections of any nearby building that result in the greatest justifiable stack height. If a stack is within five "L" (the lesser dimension of building height or building effective width) downwind, or two "L" upwind, or 1/2 "L" crosswind from the closest edge of the structure, the stack is within the sphere of influence of the structure and the structure must be considered in the GEP analysis.

All of the project stacks are less than 65-meters, therefore dispersion modeling using the stack heights is in compliance with GEP regulations. However, many stack heights are lower than the numeric formula heights. As a result, EPA's BPIP-PRIME program will be used to determine building downwash parameters which will be input to the AERMOD dispersion model.

6.0 NO₂ CONVERSION METHODOLOGY

The majority of NO_x emissions from combustion sources are in the form of nitric oxide (NO), whereas EPA has established air quality standards for NO₂. Therefore, a methodology must be used to convert model estimates of ambient NO concentrations into equivalent ambient NO₂ concentrations. EPA's Appendix W provides a three-tiered approach to calculating annual average NO₂ impacts. For the updated EJ analysis, the Tier 2 ARM2 Method in AERMOD will be used for the 1-hr NO₂ NAAQS modeling.

The default input values for ARM2 includes a minimum ambient NO₂/NO_x ratio of 0.5 and a maximum ambient ratio of 0.9. In the GAQM, EPA notes that an alternative minimum ambient ratio can be used, based on an analysis of the source's in-stack emissions ratios.

In January 2012, HOVENSA had submitted an air quality modeling protocol to EPA for potential PSD projects, but shortly thereafter the facility was idled and the protocol was never approved. That protocol contained detailed, site-specific data on the in-stack emissions ratios, which is reproduced here to support a proposed alternative ARM2 minimum ambient ratio of 0.25.

HOVENSA evaluated NO_x data from CEM systems and stack tests at the refinery, including CEMS on Boiler 10 and the 2 Visbreaker heater, the GT10 combustion turbine, and the Fluidized Catalytic Cracker (FCC) wet gas scrubber stack. While the CEM Data Acquisition System only records the total NO_x readings (only NO_x emissions are regulated), the Thermo model 42 CEM analyzer records both the NO and NO_x concentrations in internal memory for up to a one month period. Therefore, this data set was downloaded from the analyzers and processed in a spreadsheet to determine typical in-stack NO₂/NO_x ratios for these representative emission units. The data analyzed was for the time period of approximately June 8 through July 15, 2010, and periods of calibrations were removed from the data set. Table 4 summarizes the average observed in-stack NO₂ to NO_x ratios.

Table 4 – Measured In-stack NO₂/NO_x Ratio Data

Emission Unit	Ratio of In-stack NO ₂ /NO _x Concentrations
Heater – 2Vis	0.075
Boiler – B10	0.130
Turbine – GT10	0.212
FCC Wet Gas Scrubber	0.213

HOVENSA performed additional stack testing for IC engines that provide specific in-stack ratios for those types of emission units. Two compressor engines were tested, both equipped with catalytic converters, and three one-hour tests were performed on each engine. The results indicate that the highest measured ratio was 0.06, and the average ratio was 0.05.

Based on these site-specific test results, Limetree Bay Terminals and Refining proposes to use an ARM2 minimum ambient ratio of 0.25. This ratio is higher than any measured in-stack ratio, which will make the 1-hr NO₂ modeling analysis conservative. In addition, the default ARM2 maximum ambient ratio of 0.9 will be used in the 1-hr NO₂ modeling.

7.0 BACKGROUND AIR QUALITY DATA

EPA's Appendix W describes how the cumulative NAAQS analysis must consider the impacts of both modeled emission sources, as well as impacts from other sources such as natural, minor, and distant major sources that are not directly modeled through the use of background air quality data. EPA recommends, as a starting point, quantifying the background air quality using the current design value for the applicable NAAQS as a uniform monitored background contribution across the project area.

7.1 Locations of Ambient Monitors

SO₂ ambient data was collected by HOVENSA at five stations near the refinery for over ten years up until February 2013. Stations 1 through 4 were "source surveillance" monitoring sites, and Station 5 was the background air quality site. NO₂ and ozone data were also collected by HOVENSA at Stations 2 and 5 for the approximate time period January 2006 through July 2009. PM_{2.5} data is currently being collected by the Virgin Islands DPNR at the Bethlehem Housing monitoring station. Figure 6 presents a map showing the monitor locations.

The following sections describe the representative air quality data that will be used to establish the background concentrations in the vicinity of the Limetree Bay Terminals and Refining facility.

Figure 6 – Map of Air Monitoring Locations



7.2 SO₂ Background Data

The SO₂ ambient data that was collected by HOVENSA utilized SLAMS “special purpose monitor” procedures. Annual quality assurance audits were performed on the system by EPA Region 2 staff, and the data is available on EPA’s AQS online data base and Air Data website. When the refining operations were idled in early 2012, the SO₂ monitoring continued until February of 2013. Therefore, the SO₂ data from April 2012-Feb 2013 represents a period when there were no emissions from refining operations, but all other existing nearby and background sources were still operating. Therefore, combining the background SO₂ concentration from this period with the model predicted impacts of the Limetree Bay Terminals and Refining facility operating under the PAL would result in a realistic cumulative analysis, without double-counting of impacts from refining operations.

Background data from Station 5 were previously approved by EPA for use in the 2004 LSF PSD permit application air quality analysis. The data from this site has been processed both for the complete 3-year period of 2010-2012, and for the April 2012-Feb 2013 period when the refinery was idled. In addition, data from Stations 1, 2, and 3² were also processed for the April 2012-Feb 2013 timeframe. The Station 5 data capture rates are as follows: 2010 is 91.7%, 2011 is 98.9%, 2012 is 98.2%, and for the 11 month period from April 2012-Feb 2013 the capture rate is 98.7%. The data capture rates for Stations 1-3 for the April 2012-Feb 2013 time period are 95.4%, 98.7%, and 98.7%.

The 99th percentile 1-hr daily maximum SO₂ design concentration for the Station 5 three year period from 2010-2012 were directly taken from EPA’s Air Data website summary reports. The 99th percentile 1-hr daily maximum SO₂ design concentration for all sites for the April 2012-Feb 2013 time period are estimated using the 4th highest daily maximum 1-hr values. These design concentrations are presented in Table 5. This data indicates that the background SO₂ concentration at Station 5 for 2010-2012 was similar to the SO₂ concentrations measured at all stations after the refinery was idled, and that the SO₂ background without the refinery in operation is relatively uniform throughout the area.

² Station 4 readings were consistently lower than Stations 1-3, therefore Station 4 data does not add any substantive information for this analysis and was not processed.

Table 5 – Background SO₂ Data

Station # / Time Period	99th Percentile of Daily 1-hr Maximums (µg/m ³)
#5 / 2010-2012	21.8
#5 / April 2012 to February 2013	18.6
#1 / April 2012 to February 2013	18.0
#2 / April 2012 to February 2013	18.0
#3 / April 2012 to February 2013	15.9

Based on this data, a SO₂ background concentration of 21.8 µg/m³ will be used for the SO₂ 1-hr NAAQS analysis. This data is representative of impacts from nearby and distant sources that are currently operating.

7.3 NO₂ Background Data

PSD-quality NO₂ and ozone data have been collected at Station 5 for the time period January 2006 through July 2009. The objectives of this monitoring were to meet PSD pre-construction monitoring requirements and to collect representative background data for these pollutants. As noted above, Station 5 is well suited to provide background concentration data. EPA Region 2 also conducted annual quality assurance audits of these monitors, and HOVENSA had supplemented these annual audits with quarterly audits in accordance with PSD monitoring requirements.

This NO₂ data meets all standard EPA monitoring quality assurance and data capture requirements, with one exception. In early 2007, the NO₂ analyzer's photo-multiplier cooler failed, and the analyzer was inoperative from March 25 through June 18, 2007. This resulted in the data capture rate for 2007 being 75.3%. The other two years, 2006 and 2008, of NO₂ data have high data capture rates of 98% and 99%. The PSD preconstruction air monitoring requirements only require one year of pre-construction background data, and either of the years of 2006 or 2008 NO₂ data would meet the data capture requirements. Therefore, the available NO₂ data base meets PSD requirements and can be used to determine the NO₂ background concentration for the air quality analysis.

The calculated NO₂ 98th percentile daily maximum 1-hr design concentration from 2006 and 2008 was based to the 8th highest daily value, while the design concentration for 2007 was based on the 5th highest daily value (because of the lower data capture rates for 2007). These calculations follow the requirements in Table 1 of 40 CFR Part 50 Appendix S, *Interpretation of the Primary*

National Ambient Air Quality Standards for Oxides of Nitrogen (Nitrogen Dioxide). The 3 year averaged 1-hr NO₂ design concentration is 18.7 µg/m³. This data is representative of impacts from nearby and distant sources that are currently operating, with one exception. The Diageo rum distillery began operating in late 2011, after the NO₂ monitoring was discontinued. Since the impacts from Diageo are not included in the NO₂ background data, the Diageo emission units will be included in the NO₂ emission inventory used for the air dispersion modeling.

7.4 PM_{2.5} Background Data

PM_{2.5} background data is collected at the Bethlehem Housing monitoring station on St. Croix, which is a Federal Reference Method (FRM) monitoring station operated by the Virgin Islands DPNR. This site is located in a predominately downwind direction from the Limetree Bay Terminals and Refining facility at a distance of approximately 3 km. The data is available on EPA's AQS online data base and Air Data website. The design concentrations for PM_{2.5} from this station have been compiled for the last 3 years when the HOVENSA refinery was in operation, 2009-2011, as well as for the most recent, available 3-year data period, 2015 through 2017. The data is presented in Table 6.

Table 6 – Background PM_{2.5} Data

Period	Number of Samples	PM_{2.5} 24-hr Design Concentration (µg/m³)	PM_{2.5} Annual Design Concentration (µg/m³)
2009-2011	144	14.7	5.8
2015-2017	74	19.0	7.7

The data capture rates were lower for the data period 2015-2017, and the 98th percentile 24-hr design concentrations for these three years were based on the highest measured daily concentration (not the 8th highest daily concentration), in accordance with 40 CFR Part 50 Appendix N requirements. Therefore, the increases in design concentrations for the 2015-2017 period compared to the 2009-2011 period may not be a result of changes in air quality and instead may be related to the data calculation procedures. Considering this, the data suggests that there were generally similar design concentrations measured during 2009-2011 (when the HOVENSA refinery was operating) and the more recent 2015-2017 period.

This data is representative of impacts from nearby and distant sources that are currently operating, and the higher 2015-2017 design concentrations will be used for the EJ analysis. Note that this PM_{2.5} monitoring site is located in one of the COC areas defined in the 2004 HOVENSA EJ analysis. The 2015-2017 monitoring data indicate compliance with the PM_{2.5} NAAQS, which

indicates that there are no adverse PM_{2.5} impacts occurring in this COC based on monitoring results.

7.5 Summary of Background Concentrations

Table 7 summarizes the background concentration data. These values will be added to the modeled design concentrations, and the total concentration will be compared to the NAAQS.

Table 7 – Summary of Background Concentration Data

Pollutant and Averaging Interval	Background Concentration (µg/m³)
SO ₂ 1-hr Average	21.8
NO ₂ 1-hr Average	18.7
PM _{2.5} 24-hr Average	19.0
PM _{2.5} Annual Average	7.7

8.0 SECONDARY PM_{2.5} ANALYSIS

PM_{2.5} can be categorized into two groups: primary (i.e., emitted directly as PM_{2.5} from sources) and secondary (i.e., PM_{2.5} formed in the atmosphere by precursor SO₂ and NO_x emissions from sources). Air dispersion models such as AERMOD do not estimate the secondary formation of PM_{2.5} from precursor emissions. While the peak impacts of primary PM_{2.5} emissions usually occur in relatively close proximity to an emission source, the formation of secondary PM_{2.5} does require time for atmospheric oxidation to occur. Therefore, the peak secondary impacts typically occur further downwind of a source and do not necessarily overlap the peak primary impact areas.

In the previous section, historical background PM_{2.5} data was compiled from a monitoring station located in a predominately downwind direction from the Limetree Bay Terminals and Refining facility at a distance of approximately 3 km. The data indicates that the background PM_{2.5} concentrations were generally similar during 2009-2011 period (when the HOVENSA refinery was operating) and the more recent 2015-2017 period. Given the 3 km distance to the monitoring station, and assuming a wind speed of approximately 5 m/sec for typical trade winds, the transport time from the Limetree Bay Terminals and Refining facility to the monitor is only 11 minutes. Under these short transport times, there is little time for secondary particulates to form. The PM_{2.5} data suggests that SO₂ and NO_x precursor emissions from the refinery during 2009-2011 likely did not result in appreciable secondary PM_{2.5} formation at this monitoring site.

EPA has developed a tool to help assess the importance of secondary PM_{2.5} formation from SO₂ and NO_x precursor emissions, the Modeled Emission Rates for Precursors (MERPs) tool. In the final guidance document for the MERPS, dated April 2019, EPA states that the "MERP guidance is relevant for the PSD program, and only addresses assessing the effects of precursors of PM_{2.5} and O₃ for purposes of that program". Since this EJ analysis is not required under the PSD rules, the MERP guidance is not directly applicable. However, it can be used to help assess the potential importance of secondary PM_{2.5} formation.

The MERPs relate modeled emission rates and resulting downwind impacts with an air quality threshold, in this case the PM_{2.5} SIL values of 1.2 µg/m³ for the 24-hr average, and 0.3 µg/m³ for the annual average. The MERPs have been derived by analyzing photochemical modeling studies in various geographical areas in the US. Table 4-1 in the final MERP guidance tabulates the various MERP values, and Table 8 presents the daily and annual median MERP values for the Southeastern US region³. Table 8 also lists the proposed PAL SO₂ and NO_x emissions. The proposed PAL emissions are below the median MERPs for both 24-hr and annual PM_{2.5} averages. This indicates that the PAL precursor emissions should not result in secondary PM_{2.5} concentrations above the relevant SILs.

Table 8 – PAL Emissions and MERPs

PAL/MERPs	NO_x Emission (tpy)	SO₂ Emissions (tpy)
PAL Emission Limits	6,464	1,627
Daily PM _{2.5} - Median MERP	8,233	2,475
Annual PM _{2.5} - Median MERP	45,076	14,447

The overall conclusion from an analysis of PM_{2.5} data and MERPs is that secondary PM_{2.5} formation will not significantly contribute to the AERMOD predicted PM_{2.5} concentrations.

³ The MERPS guidance does not provide values for the Caribbean area; while the Southeastern US region is the closest to the facility, an analysis has not been performed to determine how representative the Southeastern US MERPs are for the Caribbean area.

9.0 EMISSION AND STACK DATA

9.1 PAL Emissions

As part of the documentation provided in the PAL permit application, Limetree Bay Terminals and Refining has presented detailed Baseline Actual Emission (BAE) annual emission calculations for each emission unit at the facility. The methods used to determine the unadjusted BAE rates include CEM data (when available) and fuel input data with emission factors (emission factors are either based on measured or stack test data, vendor-supplied emission factors, or AP-42 emission factors). For existing emission units which have not been permanently shut down, the BAE value is the emissions unit's average annual emissions in TPY for the 2009-2010 baseline period, including any downward adjustments for non-compliant emissions or for emission limits with which Limetree Bay Terminals and Refining must currently comply. For units identified as new or newly constructed, the BAE value is the emissions unit's full potential emission rate.

The proposed PAL limits are equal to the sum of the adjusted BAE plus the applicable PSD significant emission rate for each pollutant. The PAL limits are therefore slightly higher than the BAE. The PAL limits and ratios of PAL-to-BAE emissions for the pollutants that are the subject of this updated EJ analysis are shown in Table 9.

Table 9 – PAL and BAE Emissions (tpy)

Pollutant	BAE	Significant Emission Rate	PAL	Ratio PAL/BAE
NO _x	6,424	40	6,464	1.00623
PM _{2.5}	421	10	431	1.02375
SO ₂	1,587	40	1,627	1.02520

The proposed PAL emissions will be used as input to the air dispersion model. Because the PAL limits are emission caps over the entire facility, they must be apportioned to the individual emission units. This apportionment will be based on the BAE data for each emission unit, because the BAE emission data represents how the refinery typically operates. For each emission unit, the BAE emission rate will be multiplied by the PAL-to-BAE ratio to calculate the apportioned PAL emission rate for that unit. For example, the BAE SO₂ emission rate for Boiler #5 listed in the PAL permit application is 81.5 tpy, and the PAL apportioned emission rate for this unit is $(81.5 * 1.0252) = 83.6$ tpy.

9.2 Conversion of Annual Emissions to Short-term Emissions

Since the EJ analysis includes modeling for short-term air impacts of 1-hr SO₂ and NO₂, and 24-hr PM_{2.5}, a method is required to adjust the annual PAL emissions into comparable short-term emission rates. EPA Region 2 has previously developed guidance in conjunction with several other EPA Regions and the Model Clearinghouse for short-term emission calculations in terms of Table 8-2 of the GAQM. The actual short-term emission rates are based on the 90% percentile of the actual heat input (or operating level) multiplied by an emission factor such as found in AP42. If the actual heat input is not available but actual hourly mass emission rates are available from CEMS, then use the 90th percentile of the annual distribution of the measured mass emission rates as the model input. The maximum temperature and exit velocity stack parameters can be modeled with these emission rates since the maximum of these stack parameters tend to correspond with emissions from the upper 90th percentiles of the operations.

EPA has also provided additional guidance on the conversion between equivalent long-term and short-term peak emission rates using scaling factors, described in Appendices C and D of the 2014 EPA memo titled “Guidance for SO₂ 1-hr NAA SIP Submission.” The method first calculates a percentile value for both the short-term 1-hr averaged and the long-term average, and then calculates the ratio of the two values. When the ratio is the short term value divided by the long term value, it is a “long-term-to-short-term” scaling factor, and the ratio must always be greater than 1 because the peak short-term emission rate must always be higher than the long-term average. Note that in the EPA 2014 guidance memo, they calculate a “short-term-to-long-term” scaling factor using the ratio of the long-term divided by short-term values; this is because the memo describes calculating equivalent long-term limits from the “1-hr critical emission value” from modeling.

These methods of estimating short-term emissions from long-term averages are straightforward to apply when hourly heat input or hourly CEMS emission data is available for individual emission units (for example, at utility generating stations that typically have a small number of boilers or turbines with CEM systems). However, the Limetree Bay Terminals and Refining facility is a large and complex operation that includes 6 boilers, 7 turbines, and 91 process heaters. Most of these emission units do not have CEMS, and many of the heaters do not have individual fuel flow meters (fuel flow rate is measured at the process unit level). Also, because of the temporary idling of the facility in 2012, access to the previous computer servers with detailed CEMS hourly data and hourly fuel usage data is difficult and in some cases not possible.

Therefore, Limetree Bay Terminals and Refining staff has compiled hourly heat input and CEMS data for some representative boilers, turbines, and heater from available records and backed up data reports. Hourly heat input data was compiled for the 2 year BAE period of 2009-2010 for the No.8 and 9 boilers (the second and third largest boilers by heat input capacity), the turbines GT9 and GT10, and the Crude 5 heater (which is one of the largest heaters at the facility). For GT10 and the Crude 5 heater, hourly heat input data was only available for approximately one year, starting in 2009. In addition, hourly NO_x CEMS data was available for GT 9 for 2009-2010, and for GT10 for 2009.

This hourly heat input and CEMS data has been analyzed based on the procedures described above. The 90th percentile value for the available hourly data was calculated and then divided by the overall average to determine the “annual-average-to-short-term” scaling factor. Table 10 presents these results. This data indicates that the peak 1-hr short term values are generally about 1.2 to 1.9 times higher than the average rates.

Table 10 – Scaling Factors for Short-term Emission Rates

Emission Unit/Parameter	90th Percentile Value	Average Value	Ratio of 90th Percentile to Average
GT9 Heat Input (MMBtu/hr)	255	145	1.8
GT10 Heat Input (MMBtu/hr)	252	179	1.4
Boiler 8 Heat input (MMBtu/hr)	301	185	1.6
Boiler 9 Heat input (MMBtu/hr)	269	139	1.9
Crude 5 Heaters Total Heat Input (MMBtu/hr)	433	375	1.2
GT9 NO _x CEM Data (lb/hr)	29.1	23.8	1.2
GT10 NO _x CEM Data (lb/hr)	28.2	22.7	1.2

Based on these results, a simple yet conservative approach to estimating the peak short-term emissions from the PAL annual emissions is to simply double the PAL emissions for the short-term modeling analyses using a scaling factor of 2. While some of the data indicate that a lower scaling factor would be appropriate for some types of emission units, it is simpler to use a uniform scaling factor of 2 for all emission units at the facility. This will result in a conservative estimate of peak short-term emissions for the EJ air modeling analysis.

9.3 Calculation Example and Modeled Emission and Stack Data

The following example summarizes and demonstrates how the short-term emission rates have been calculated for the modeling analysis. Again using Boiler #5 SO₂ emission data as the example, the first step is calculating the PAL apportioned annual emission rate by multiplying the BAE emission rate by the PAL-to-BAE ratio. The BAE SO₂ emission rate for Boiler #5 of 81.5 is multiplied by the PAL/BAE ratio of 1.02520 to calculate the annual PAL emissions of 83.6 tpy. The second step is to convert the annual PAL emissions to short-term emissions. This is done by first scaling the annual emissions by a factor of 2 to account for short-term variability, and then converting the emission units from tpy to grams/second for input to the AERMOD model. The Boiler # 5 PAL emission rate of 83.6 is scaled by 2 and then multiplied by 0.02875 to calculate the short-term SO₂ emission rate of 4.81 grams/second.

Appendix B presents a table that lists the modeled emission rates and stack parameters for all of the Limetree Bay Terminals and Refining emission units in the PAL application. The stack parameters are based on previous HOVENSA tabulated data, which was derived from stack tests and engineering calculations. The only stack parameters that were changed were the flow rate for the H602-H605 heater stack because two of the four heaters are being retired; the flow rate was linearly reduced by the ratio of the modified versus original total heat input rates for this stack.

9.4 Other Sources included in the Modeling

As discussed in the background air quality Section 7 of this report, in addition to emissions from the Limetree Bay Terminals and Refining facility, the NO_x emissions from the Diageo distillery must be included in the 1-hr NO₂ modeling analysis. The Diageo potential emission rates and stack parameters for two boilers, one sludge dryer, and a flare were taken from both the Diageo air permit, as well as the AEG Anguilla Power Renewable Energy Power Generation Project modeling analysis. The potential emission rates⁴ and stack parameters used for the EJ analysis are presented in Table 11. Note that the intermittent emissions from the Diageo emergency generators were not included in the EJ modeling analysis.

⁴ EPA guidance is to model actual emissions for nearby sources; however, actual emission data was not readily available for the Diageo sources.

Table 11 – Diageo NO_x Emission Sources Modeled Data

Source	UTM E (m)	UTM N (m)	Base Elev. (m)	Stack Ht (m)	Temp. (K)	Exit Vel. (m/s)	Stack Dia. (m)	NO _x (lb/hr)
DIAGEO Boilers 1-2	311614	1959412	27.4	16.46	424.8	16.03	0.8	23.6
Diageo Dryer	311524	1959432	27.4	7.62	366.5	13.66	0.25	2.22
DIAGEO Flare	311435	1959414	27.4	15.24	922.0	13.64	3.05	5.41

10.0 AIR MODELING RESULTS

Table 12 presents the maximum cumulative model predicted air concentrations (in combination with background air concentration data). These results indicate compliance with the 1-hr SO₂, 1-hr NO₂, and 24-hr and annual PM_{2.5} NAAQS. Since the total impacts are less than the NAAQS, the analysis demonstrates that there are no adverse impacts at any location near the facility, including any COC areas.

The locations of the highest model-predicted impacts (without background concentrations) are presented in Figures 7 through 10. The impacts are plotted on the 2004 EJ COC base maps provided by EPA Region 2. While these COC areas have not been updated, they are likely still indicative of the EJ communities in the area. These figures indicate that the maximum impacts are not disproportionately occurring in EJ communities.

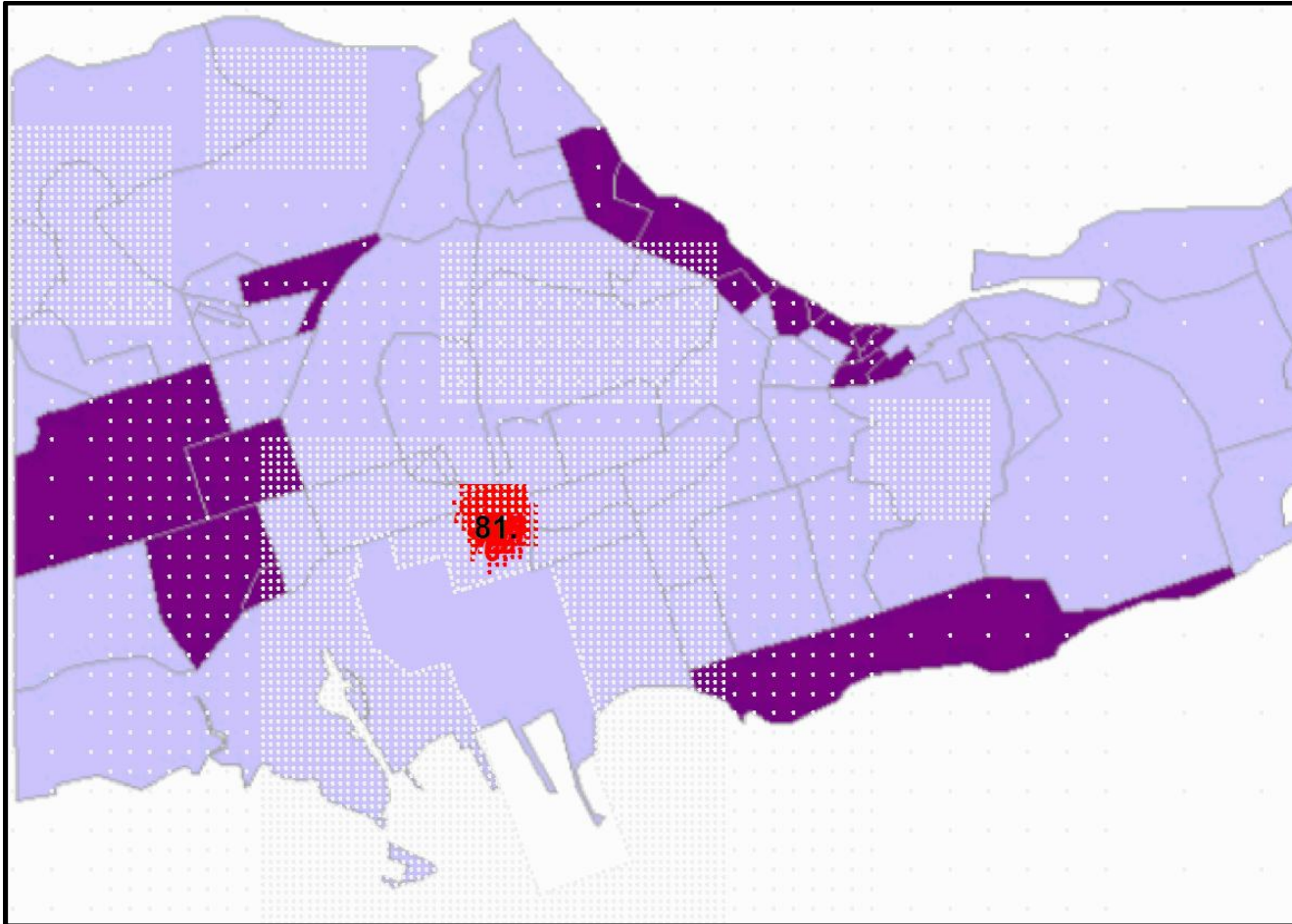
In summary, this updated EJ analysis demonstrates that the impacts of the Limetree Bay Terminals and Refining facility, in cumulative combination with other nearby emission sources and background air concentrations, will not result in adverse or disproportionate EJ impacts.

Table 12 – Summary of Modeling Results

Pollutant / Averaging Interval	Modeled Design Concentration	Background Concentration	Total Concentration	NAAQS
1-hr SO ₂	81.4	21.8	103.2	196
1-hr NO ₂	146.6	18.7	165.3	188
24-hr PM _{2.5}	8.2	19.0	27.2	35
Annual PM _{2.5}	1.8	7.7	9.5	12

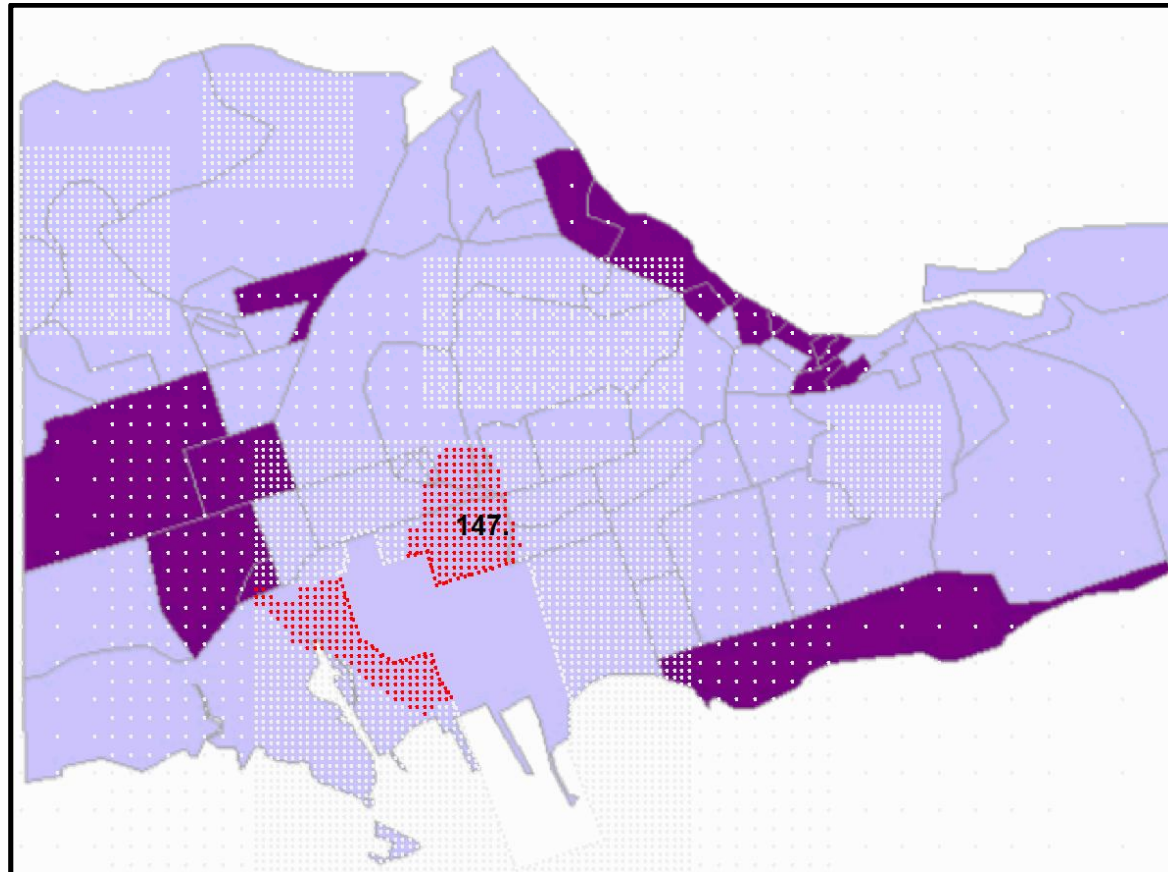
Note: All concentrations are in units of µg/m³.

Figure 7 – Plot of Highest 1-hr SO₂ Modeled Impacts



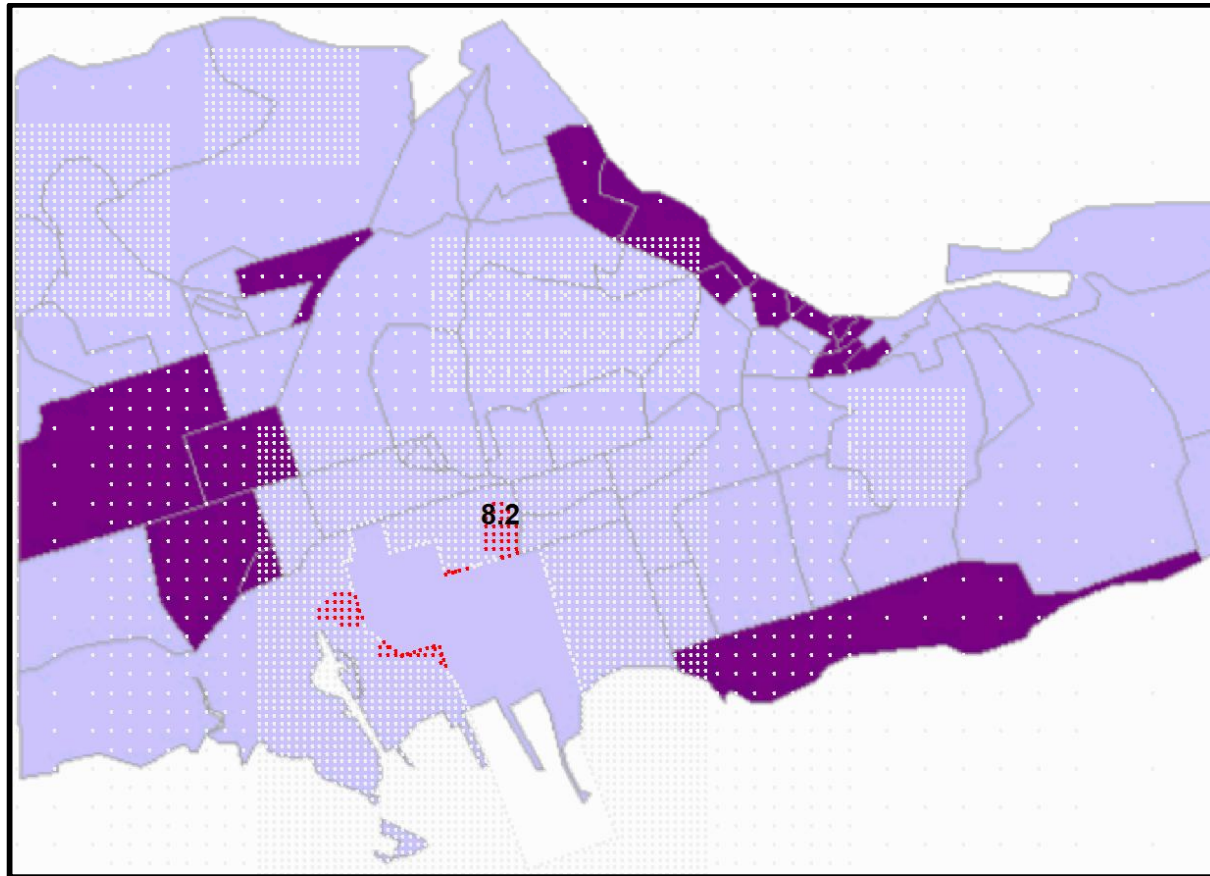
Note: The red dots are receptors with impacts greater than 70 $\mu\text{g}/\text{m}^3$, and the maximum impact is located at the 81 $\mu\text{g}/\text{m}^3$ marker. The data indicates that none of the elevated impacts are occurring in COC areas (identified as purple areas in the plot).

Figure 8 – Plot of Highest 1-hr NO₂ Modeled Impacts



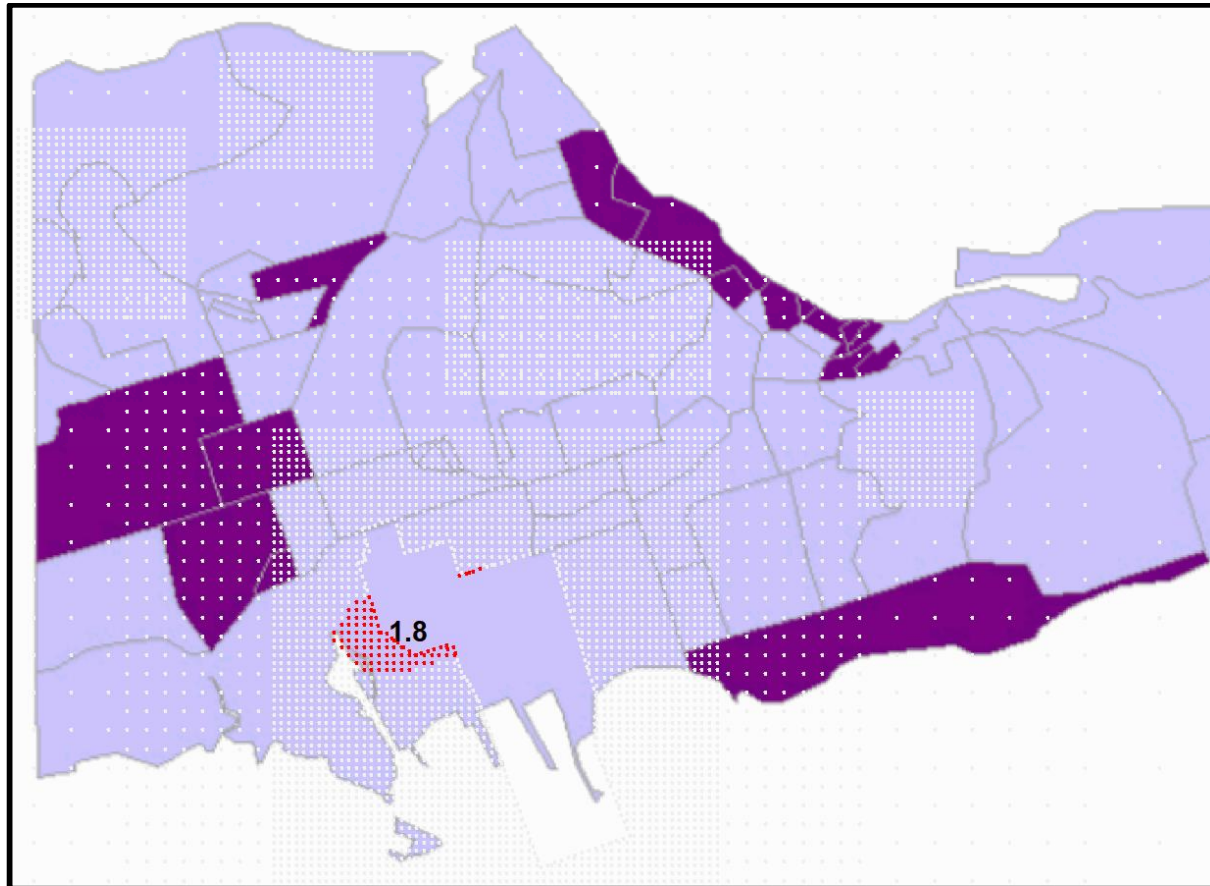
Note: The red dots are all receptors with impacts greater than 130 µg/m³, and the maximum impact is located at the 147 µg/m³ marker. The data indicates that the elevated impacts are not disproportionately occurring in COC areas (identified as purple areas in the plot).

Figure 9 – Plot of Highest 24-hr PM_{2.5} Modeled Impacts



Note: The red dots are all receptors with impacts greater than 6 µg/m³, and the maximum impact is located at the 8.2 µg/m³ marker. The data indicates that none of the elevated impacts are occurring in COC areas (identified as purple areas in the plot).

Figure 10 – Plot of Highest Annual PM_{2.5} Modeled Impacts



Note: The red dots are all receptors with impacts greater than 1.25 µg/m³, and the maximum impact is located at the 1.8 µg/m³ marker. The data indicates that none of the elevated impacts are occurring in COC areas (identified as purple areas in the plot).

APPENDIX A

AERMET Surface Characteristic Calculations

HOVENSA Inverse-distance weighted geometric mean surface roughness calculations														
HOVENSA Cottage Meteorological Station														
Sector 1	Start 60	End 105	Arc rad 0.7854	Total area m2	392,500	Centroid 0.6497	Surface Roughness Table A-3 AERMET				Weighted Surface Roughness			
LULCCode	Type	Area m2	Area %	Ave Distance km	Weighting Factor	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	
41	Forested		0%			N/A	N/A	0.6	N/A	N/A	N/A		N/A	
71	Shrubland		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
31	Quarry/Gravel/Tailings		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
21	Low Residential	345486	88%	0.650	1.3548	N/A	N/A	0.54	N/A	N/A	N/A	0.43396	N/A	
11	Water		0%			N/A	N/A	0.001	N/A	N/A	N/A		N/A	
23	Industrial	47014	12%	0.900	0.1331	N/A	N/A	0.8	N/A	N/A	N/A	0.97074	N/A	
TOTALS		392,500	100%		1.4879							0.4213		
Inverse-distance weighted geometric mean surface roughness for this sector =												0.559322		
Sector 2	Start 105	End 260	Arc rad 2.7053	Total area m2	1,351,944	Centroid 0.4812	Surface Roughness Table A-3 AERMET				Weighted Surface Roughness			
LULCCode	Type	Area m2	Area %	Ave Distance km	Weighting Factor	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	
41	Forested		0%			N/A	N/A	0.6	N/A	N/A	N/A		N/A	
71	Shrubland		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
31	Quarry/Gravel/Tailings		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
21	Low Residential	231217	17%	0.210	0.8144	N/A	N/A	0.54	N/A	N/A	N/A	0.60542	N/A	
11	Water		0%			N/A	N/A	0.001	N/A	N/A	N/A		N/A	
23	Industrial	1,120,727	83%	0.701	1.1826	N/A	N/A	0.8	N/A	N/A	N/A	0.76807	N/A	
TOTALS		1,351,944	100%		1.997							0.4650		
Inverse-distance weighted geometric mean surface roughness for this sector =												0.681516		
Sector 3	Start 260	End 320	Arc rad 1.0472	Total area m2	523,333	Centroid 0.6366	Surface Roughness Table A-3 AERMET				Weighted Surface Roughness			
LULCCode	Type	Area m2	Area %	Ave Distance km	Weighting Factor	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	
41	Forested	393,009	75%	0.637	1.1796	N/A	N/A	0.6	N/A	N/A	N/A	0.54740	N/A	
71	Shrubland		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
31	Quarry/Gravel/Tailings		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
21	Low Residential	130324	25%	0.850	0.2930	N/A	N/A	0.54	N/A	N/A	N/A	0.83483	N/A	
11	Water		0%			N/A	N/A	0.001	N/A	N/A	N/A		N/A	
23	Industrial		0%			N/A	N/A	0.8	N/A	N/A	N/A		N/A	
TOTALS		523,333	100%		1.473							0.4570		
Inverse-distance weighted geometric mean surface roughness for this sector =												0.587554		
Sector 4	Start 320	End 60	Arc rad 1.7453	Total area m2	872,222	Centroid 0.5852	Surface Roughness Table A-3 AERMET				Weighted Surface Roughness			
LULCCode	Type	Area m2	Area %	Ave Distance km	Weighting Factor	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	
41	Forested	210,356	24%	0.680	0.3547	N/A	N/A	0.6	N/A	N/A	N/A	0.83429	N/A	
71	Shrubland		0%			N/A	N/A	0.3	N/A	N/A	N/A		N/A	
31	Rock (arid)		0%			N/A	N/A	0.05	N/A	N/A	N/A		N/A	
21	Low Residential	661866	76%	0.585	1.2967	N/A	N/A	0.54	N/A	N/A	N/A	0.44978	N/A	
11	Water		0%			N/A	N/A	0.001	N/A	N/A	N/A		N/A	
23	Industrial													

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HOVENSA Geometric Mean Bowen ratio and Arithmetic Mean Albedo Calculations											
Calculations based on 10 km by 10 km domain											
Bowen ratio Geometric mean											
Total area m2	100,000,000										
				Bowen Ratio				Geometric Mean Calculations			
LULCCode	Type	Area m2	Area %	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
41	Forested	8082280	8.1%	N/A	N/A	0.3	N/A	N/A	N/A	0.90728	N/A
71	Grassland	34,663,419	34.7%	N/A	N/A	0.8	N/A	N/A	N/A	0.92557	N/A
21	Low Res	11484424	11.5%	N/A	N/A	0.8	N/A	N/A	N/A	0.97470	N/A
11	Water	35885367	35.9%	N/A	N/A	0.1	N/A	N/A	N/A	0.43767	N/A
23	Industrial	9884510	9.9%	N/A	N/A	1.5	N/A	N/A	N/A	1.04089	N/A
TOTALS			100%								
								Geometric mean Bowen ratio		0.3729	
Albedo arithmetic mean											
Total area m2	100,000,000										
				Albedo				Arithmetic Mean Calculations			
LULCCode	Type	Area m2	Area %	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall
41	Forested	8082280	8.1%	N/A	N/A	0.16	N/A	N/A	N/A	0.01293	N/A
71	Grassland	34,663,419	34.7%	N/A	N/A	0.18	N/A	N/A	N/A	0.06239	N/A
21	Low Res	11484424	11.5%	N/A	N/A	0.16	N/A	N/A	N/A	0.01838	N/A
11	Water	35885367	35.9%	N/A	N/A	0.10	N/A	N/A	N/A	0.03589	N/A
23	Industrial	9884510	9.9%	N/A	N/A	0.18	N/A	N/A	N/A	0.01779	N/A
TOTALS			100%								
								Arithmetic mean Albedo		0.1474	

APPENDIX B

Emission and Stack Data

Limetree Bay EJ Analysis - Emissions and Stack Parameters - Point Sources												
Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev.	Stack Ht	Temp.	Exit Vel.	Stack Dia.	SO2	NO2	24hr PM25	Ann PM-25
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(g/s)	(g/s)	(g/s)	(g/s)
H101	1Vis	313,337	1,959,355	11.6	59.7	671.7	4.5	3.40	3.06E-01	3.34E+00	1.22E-01	6.08E-02
H104	1Vis	313,348	1,959,359	11.6	59.4	671.7	9.7	2.00	2.74E-01	2.78E+00	1.04E-01	5.19E-02
H160	UtlFract	313,411	1,959,271	11.6	59.4	588.4	7.6	2.30	7.90E-02	3.51E+00	9.70E-02	4.85E-02
H200	Penex	313,364	1,959,245	11.6	20.7	644.0	6.9	1.50	3.30E-02	1.08E+00	4.27E-02	2.14E-02
H201	Penex	313,405	1,959,257	11.6	21.6	588.4	5.3	1.70	3.30E-02	8.58E-01	4.34E-02	2.17E-02
H202	Penex	313,381	1,959,249	11.6	31.4	560.6	2.5	3.10	8.30E-02	3.47E+00	9.60E-02	4.80E-02
C200A	Penex	313,350	1,959,300	11.6	10.7	796.7	12.4	0.50	1.00E-03	2.25E-01	2.15E-02	1.07E-02
C200B	Penex	313,343	1,959,298	11.6	10.7	796.7	12.4	0.50	1.00E-03	1.09E-01	2.15E-02	1.07E-02
C200C	Penex	313,335	1,959,295	11.6	10.7	796.7	12.4	0.50	1.00E-03	1.07E-01	2.15E-02	1.07E-02
H401A	2CDU	313,211	1,959,286	11.6	59.4	555.1	13.5	1.90	1.57E+00	4.48E+00	2.99E-01	1.50E-01
H401B	2CDU	313,214	1,959,278	11.6	59.4	555.1	13.5	1.90	1.57E+00	4.48E+00	2.99E-01	1.50E-01
H401C	2CDU	313,216	1,959,270	11.6	59.4	555.1	13.5	1.90	1.57E+00	4.48E+00	2.99E-01	1.50E-01
H601	2Plat	312,903	1,959,163	11.6	22.0	616.2	8.1	1.20	1.70E-02	3.14E-01	2.43E-02	1.21E-02
H602~5	2Plat	312,934	1,959,170	11.6	46.9	866.2	1.9	3.70	2.10E-02	3.90E-01	3.01E-02	1.51E-02
H800AB&1	2DD	313,032	1,959,203	11.6	59.4	855.1	20.0	2.10	1.51E-01	2.37E+00	1.87E-01	9.36E-02
C1500A	3DD	313,380	1,959,322	11.6	12.2	866.2	9.0	0.30	0.00E+00	4.96E-01	4.30E-03	2.20E-03
C1500B	3DD	313,388	1,959,324	11.6	12.2	866.2	9.0	0.30	0.00E+00	4.96E-01	4.30E-03	2.20E-03
C1500C	3DD	313,395	1,959,327	11.6	12.2	866.2	9.0	0.30	0.00E+00	4.96E-01	4.30E-03	2.20E-03
H2201A_1	4DD	312,777	1,959,251	11.6	18.6	699.5	14.7	0.90	2.70E-02	4.90E-01	3.79E-02	1.89E-02
H2201A_2	4DD	312,783	1,959,253	11.6	18.6	699.5	14.7	0.90	2.70E-02	4.90E-01	3.79E-02	1.89E-02
H2201B_1	4DD	312,788	1,959,215	11.6	18.6	699.5	14.7	0.90	2.70E-02	4.90E-01	3.79E-02	1.89E-02
H2201B_2	4DD	312,795	1,959,216	11.6	18.6	699.5	14.7	0.90	2.70E-02	4.90E-01	3.79E-02	1.89E-02
H2202_1	4DD	312,784	1,959,227	11.6	22.9	677.3	8.9	1.20	2.70E-02	6.24E-01	3.58E-02	1.79E-02
H2202_2	4DD	312,787	1,959,229	11.6	22.9	677.3	8.9	1.20	2.70E-02	6.24E-01	3.58E-02	1.79E-02
H2202_3	4DD	312,790	1,959,230	11.6	22.9	677.3	8.9	1.20	2.70E-02	6.24E-01	3.58E-02	1.79E-02
H2400_1	5DD	312,897	1,959,292	11.6	21.0	716.2	7.9	0.90	1.80E-02	3.29E-01	2.54E-02	1.27E-02
H2400_2	5DD	312,901	1,959,293	11.6	21.0	716.2	7.9	0.90	1.80E-02	3.29E-01	2.54E-02	1.27E-02
C2400A	5DD	312,820	1,959,262	11.6	25.0	866.2	4.4	1.00	0.00E+00	2.41E-01	1.39E-02	7.00E-03
C2400B	5DD	312,823	1,959,252	11.6	10.0	866.2	10.8	0.50	0.00E+00	3.99E-02	1.39E-02	7.00E-03
H2501_1	NaphFrac	312,665	1,959,164	11.6	28.5	616.2	7.2	1.40	1.20E-02	1.79E-01	1.60E-02	8.00E-03
H2501_2	NaphFrac	312,664	1,959,168	11.6	28.5	616.2	7.2	1.40	1.20E-02	1.79E-01	1.60E-02	8.00E-03
H2501_3	NaphFrac	312,663	1,959,171	11.6	28.5	616.2	7.2	1.40	1.20E-02	1.79E-01	1.60E-02	8.00E-03
H3101A	5CDU	314,375	1,959,610	11.6	60.0	449.5	9.1	3.00	4.14E+00	1.15E+01	7.34E-01	3.67E-01
H3101B	5CDU	314,384	1,959,614	11.6	60.0	449.5	9.1	3.00	4.46E+00	1.27E+01	7.98E-01	3.99E-01
H4101A	6CDU	314,536	1,959,663	11.6	60.0	477.3	10.2	3.00	3.63E+00	1.21E+01	6.83E-01	3.41E-01

Limetree Bay EJ Analysis - Emissions and Stack Parameters - Point Sources												
Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev.	Stack Ht	Temp.	Exit Vel.	Stack Dia.	SO2	NO2	24hr PM25	Ann PM-25
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(g/s)	(g/s)	(g/s)	(g/s)
H4101B	6CDU	314,544	1,959,666	11.6	60.0	477.3	10.2	3.00	3.96E+00	1.38E+01	7.56E-01	3.78E-01
H4201&2	3Vac	314,457	1,959,440	10.1	60.0	449.5	8.3	3.70	6.95E+00	1.36E+01	1.12E+00	5.62E-01
H4301A_1	7DD	314,517	1,959,271	10.1	16.8	671.7	8.1	0.90	5.10E-02	2.61E-01	2.01E-02	1.01E-02
H4301A_2	7DD	314,522	1,959,273	10.1	16.8	671.7	8.1	0.90	5.10E-02	2.61E-01	2.01E-02	1.01E-02
H4301A_3	7DD	314,526	1,959,274	10.1	16.8	671.7	8.1	0.90	5.10E-02	2.61E-01	2.01E-02	1.01E-02
H4301B_1	7DD	314,513	1,959,287	10.1	16.8	671.7	8.1	0.90	5.30E-02	2.71E-01	2.10E-02	1.05E-02
H4301B_2	7DD	314,516	1,959,288	10.1	16.8	671.7	8.1	0.90	5.30E-02	2.71E-01	2.10E-02	1.05E-02
H4301B_3	7DD	314,520	1,959,289	10.1	16.8	671.7	8.1	0.90	5.30E-02	2.71E-01	2.10E-02	1.05E-02
H4302_1	7DD	314,522	1,959,257	10.1	19.8	671.7	11.2	1.50	1.46E-01	7.77E-01	5.78E-02	2.89E-02
H4302_2	7DD	314,529	1,959,259	10.1	19.8	671.7	11.2	1.50	1.46E-01	7.77E-01	5.78E-02	2.89E-02
H4401_1	3Plat	314,605	1,959,368	10.1	22.0	599.5	10.6	1.50	1.44E-01	9.65E-01	5.63E-02	2.81E-02
H4401_2	3Plat	314,603	1,959,374	10.1	22.0	599.5	10.6	1.50	1.44E-01	9.65E-01	5.63E-02	2.81E-02
H4402_1	3Plat	314,595	1,959,365	10.1	21.3	535.6	5.8	1.50	1.01E-01	1.43E+00	3.96E-02	1.98E-02
H4402_2	3Plat	314,593	1,959,371	10.1	21.3	535.6	5.8	1.50	1.01E-01	1.43E+00	3.96E-02	1.98E-02
H4451-4	3Plat	314,627	1,959,380	10.1	44.2	505.1	7.7	5.50	1.85E+00	1.45E+01	7.22E-01	3.61E-01
H4455_1	3Plat	314,615	1,959,371	10.1	21.3	532.9	9.1	1.50	1.52E-01	7.01E-01	5.90E-02	2.95E-02
H4455_2	3Plat	314,614	1,959,377	10.1	21.3	532.9	9.1	1.50	1.52E-01	7.01E-01	5.90E-02	2.95E-02
H4502_1	2Sulf	314,642	1,959,745	11.6	19.8	685.6	10.4	1.20	1.21E-01	1.71E+00	4.71E-02	2.36E-02
H4502_2	2Sulf	314,649	1,959,747	11.6	19.8	685.6	10.4	1.20	1.21E-01	1.71E+00	4.71E-02	2.36E-02
H4503_1	2Sulf	314,639	1,959,756	11.6	19.8	685.6	12.1	1.20	1.06E-01	1.50E+00	4.14E-02	2.07E-02
H4503_2	2Sulf	314,645	1,959,758	11.6	19.8	685.6	12.1	1.20	1.06E-01	1.50E+00	4.14E-02	2.07E-02
H4504_1	2Sulf	314,649	1,959,725	11.6	20.4	685.6	9.5	1.20	8.50E-02	1.21E+00	3.33E-02	1.67E-02
H4504_2	2Sulf	314,653	1,959,727	11.6	20.4	685.6	9.5	1.20	8.50E-02	1.21E+00	3.33E-02	1.67E-02
H4505_1	2Sulf	314,646	1,959,735	11.6	17.4	671.7	5.8	1.20	6.60E-02	9.35E-01	2.58E-02	1.29E-02
H4505_2	2Sulf	314,650	1,959,736	11.6	17.4	671.7	5.8	1.20	6.60E-02	9.35E-01	2.58E-02	1.29E-02
H4601A_1	6DD	314,488	1,959,367	10.1	18.6	699.5	14.8	0.90	4.30E-02	2.18E-01	1.69E-02	8.40E-03
H4601A_2	6DD	314,494	1,959,369	10.1	18.6	699.5	14.8	0.90	4.30E-02	2.18E-01	1.69E-02	8.40E-03
H4601B_1	6DD	314,499	1,959,330	10.1	18.6	699.5	14.8	0.90	4.30E-02	2.17E-01	1.68E-02	8.40E-03
H4601B_2	6DD	314,505	1,959,332	10.1	18.6	699.5	14.8	0.90	4.30E-02	2.17E-01	1.68E-02	8.40E-03
H4602_1	6DD	314,495	1,959,344	10.1	22.9	677.3	9.0	1.20	6.30E-02	3.46E-01	2.45E-02	1.22E-02
H4602_2	6DD	314,498	1,959,345	10.1	22.9	677.3	9.0	1.20	6.30E-02	3.46E-01	2.45E-02	1.22E-02
H4602_3	6DD	314,501	1,959,346	10.1	22.9	677.3	9.0	1.20	6.30E-02	3.46E-01	2.45E-02	1.22E-02
C4601A	6DD	314,414	1,959,354	11.6	10.7	727.3	27.6	0.50	1.00E-03	4.49E+00	1.27E-02	6.40E-03
C4601B	6DD	314,420	1,959,355	11.6	10.7	727.3	27.6	0.50	1.00E-03	4.33E+00	1.27E-02	6.40E-03
C4601C	6DD	314,426	1,959,357	11.6	10.7	727.3	27.6	0.50	1.00E-03	4.05E+00	1.27E-02	6.40E-03

Limetree Bay EJ Analysis - Emissions and Stack Parameters - Point Sources												
Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev.	Stack Ht	Temp.	Exit Vel.	Stack Dia.	SO2	NO2	24hr PM25	Ann PM-25
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(g/s)	(g/s)	(g/s)	(g/s)
H5301A_1	9DD	314,782	1,959,469	10.1	16.8	671.7	9.7	0.90	4.40E-02	2.23E-01	1.72E-02	8.60E-03
H5301A_2	9DD	314,787	1,959,470	10.1	16.8	671.7	9.7	0.90	4.40E-02	2.23E-01	1.72E-02	8.60E-03
H5301A_3	9DD	314,791	1,959,471	10.1	16.8	671.7	9.7	0.90	4.40E-02	2.23E-01	1.72E-02	8.60E-03
H5301B_1	9DD	314,777	1,959,485	10.1	16.8	671.7	9.7	0.90	4.20E-02	2.13E-01	1.64E-02	8.20E-03
H5301B_2	9DD	314,782	1,959,486	10.1	16.8	671.7	9.7	0.90	4.20E-02	2.13E-01	1.64E-02	8.20E-03
H5301B_3	9DD	314,786	1,959,487	10.1	16.8	671.7	9.7	0.90	4.20E-02	2.13E-01	1.64E-02	8.20E-03
H5302_1	9DD	314,788	1,959,456	10.1	19.8	671.7	9.5	1.50	1.77E-01	1.07E+00	6.90E-02	3.45E-02
H5302_2	9DD	314,795	1,959,458	10.1	19.8	671.7	9.5	1.50	1.77E-01	1.07E+00	6.90E-02	3.45E-02
H5401_1	4Plat	314,644	1,959,243	10.1	22.0	599.5	9.5	1.50	1.38E-01	8.76E-01	5.40E-02	2.70E-02
H5401_2	4Plat	314,643	1,959,249	10.1	22.0	599.5	9.5	1.50	1.38E-01	8.76E-01	5.40E-02	2.70E-02
H5402_1	4Plat	314,634	1,959,240	10.1	21.3	535.6	5.9	1.50	9.50E-02	1.36E+00	3.76E-02	1.88E-02
H5402_2	4Plat	314,633	1,959,246	10.1	21.3	535.6	5.9	1.50	9.50E-02	1.36E+00	3.76E-02	1.88E-02
H5451-4	4Plat	314,668	1,959,258	10.1	44.2	505.1	6.2	5.50	1.60E+00	1.18E+01	6.31E-01	3.16E-01
H5455_1	4Plat	314,654	1,959,246	10.1	21.3	532.9	9.5	1.50	1.42E-01	8.74E-01	5.57E-02	2.78E-02
H5455_2	4Plat	314,652	1,959,252	10.1	21.3	532.9	9.5	1.50	1.42E-01	8.74E-01	5.57E-02	2.78E-02
7801	SulfAcid	314,930	1,958,949	10.1	38.1	616.0	3.5	1.50	4.00E-03	1.59E-01	1.93E-02	9.70E-03
H1032	1SRU	313,284	1,958,804	11.6	59.4	810.6	2.2	1.20	1.70E-02	1.38E-02	1.10E-03	5.00E-04
H1042	2SRU	313,288	1,958,791	11.6	59.4	810.6	4.5	1.20	6.00E-03	1.04E-01	8.10E-03	4.00E-03
H4745	3&4SRU	314,703	1,958,993	8.5	59.4	921.7	6.8	2.00	1.48E+01	2.02E-01	1.56E-02	7.80E-03
H1061	1Beavon	313,257	1,958,850	11.6	37.2	354.0	18.7	0.80	0.00E+00	1.14E-01	1.92E-02	9.60E-03
H4761	TGTU	314,680	1,959,066	8.5	37.2	354.0	24.5	0.80	5.20E-02	1.14E-01	1.92E-02	9.60E-03
B1155	5Boiler	313,225	1,959,398	9.5	60.0	477.3	15.6	2.40	4.81E+00	8.64E+00	8.48E-01	4.24E-01
B3301&2	6-7Boilr	314,491	1,959,606	11.6	60.0	477.3	15.6	2.40	6.38E+00	1.41E+01	1.06E+00	5.31E-01
B3303&4	8-9Boilr	314,562	1,959,615	11.6	60.0	477.3	11.7	3.90	1.37E+01	2.23E+01	2.23E+00	1.11E+00
B3307	10Boiler	314,505	1,959,471	11.6	29.3	449.9	10.8	2.00	4.29E-01	1.57E+00	1.68E-01	8.41E-02
G3404	GT#4	314,562	1,959,598	11.6	15.2	485.9	21.4	3.20	7.48E-01	3.03E+01	4.27E-01	2.13E-01
G3405	GT#5	314,569	1,959,576	11.6	15.2	485.9	21.4	3.20	6.99E-01	2.92E+01	3.91E-01	1.96E-01
G3407	GT#7	314,585	1,959,524	11.6	11.6	485.9	21.4	3.20	8.28E-01	3.79E+01	4.71E-01	2.35E-01
G3408	GT#8	314,599	1,959,496	11.6	11.6	485.9	27.8	3.10	5.13E-01	2.06E+01	2.63E-01	1.32E-01
G3409	GT#9	314,643	1,959,513	11.6	15.2	485.9	17.2	3.40	8.43E-01	4.58E+00	4.81E-01	2.41E-01
G3410	GT#10	314,691	1,959,529	11.6	22.9	485.9	17.6	3.50	6.71E-01	5.06E+00	3.82E-01	1.91E-01
HEATER1	CokeHtr1	315,188	1,958,329	8.5	45.7	449.9	7.5	2.60	3.16E-01	9.26E-01	1.72E-01	8.58E-02
HEATER2	CokeHtr2	315,163	1,958,317	8.5	45.7	449.9	7.5	2.60	3.18E-01	1.03E+00	8.19E-02	4.10E-02
7051	WetScrub	314,891	1,959,186	10.1	70.0	335.8	20.1	3.40	1.65E+00	5.12E+00	5.08E+00	2.54E+00
7802	SAPStack	314,867	1,958,918	10.1	59.7	355.2	10.7	0.80	4.29E+00	4.70E-01	0.00E+00	0.00E+00

Limetree Bay EJ Analysis - Emissions and Stack Parameters - Point Sources												
Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev.	Stack Ht	Temp.	Exit Vel.	Stack Dia.	SO2	NO2	24hr PM25	Ann PM-25
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(g/s)	(g/s)	(g/s)	(g/s)
H1105	2FlareW	313,109	1,958,650	11.6	61.0	1,273.0	20.0	30.90	1.24E+00	3.11E+00	3.47E-01	1.74E-01
H1104	3FlareW	313,218	1,958,600	11.6	61.0	1,273.0	20.0	30.90	6.16E-01	1.55E+00	1.73E-01	8.64E-02
H3351	5FlareE	314,655	1,958,786	11.6	61.0	1,273.0	20.0	30.90	8.97E-01	2.26E+00	2.52E-01	1.26E-01
H3352	6FlareE	314,680	1,958,696	11.6	61.0	1,273.0	20.0	30.90	4.44E-01	1.12E+00	1.24E-01	6.22E-02
H3301	7FlareE	314,739	1,958,811	11.6	61.0	1,273.0	20.0	30.90	1.46E+00	3.67E+00	4.09E-01	2.05E-01
7941	LPFlareE	314,767	1,958,722	11.6	65.0	1,273.0	20.0	23.90	9.95E-01	2.50E+00	2.79E-01	1.39E-01
7942	GrdHPFIE	315,265	1,957,781	3.0	0.6	1,273.0	20.0	31.20	1.77E-01	4.44E-01	4.95E-02	2.48E-02
G3413	GT13	314,735	1,959,586	11.6	24.1	483.0	23.9	3.00	2.16E-01	1.58E+00	6.61E-01	3.31E-01
P1602	SealIntak	314,849	1,958,070	3.0	6.0	799.9	16.6	0.20	2.40E-02	3.59E-01	2.59E-02	1.30E-02
P1603	SealIntak	314,853	1,958,071	3.0	6.0	799.9	16.6	0.20	2.40E-02	3.59E-01	2.59E-02	1.30E-02
P1604	SealIntak	314,858	1,958,073	3.0	6.0	799.9	16.6	0.20	2.40E-02	3.59E-01	2.59E-02	1.30E-02
P1605	SealIntak	314,863	1,958,076	3.0	6.0	799.9	16.6	0.20	2.40E-02	3.59E-01	2.59E-02	1.30E-02
DAG_BLR1	DIAGEO Boiler #1	311,614	1,959,412		16.5	424.8	16.0	0.80	0.00E+00	2.96E+00	0.00E+00	0.00E+00
DAG_DRY	Diageo Dryer	311,524	1,959,432		7.6	366.5	13.7	0.25	0.00E+00	2.80E-01	0.00E+00	0.00E+00
DAG_FLAR	DIAGEO Flare	311,435	1,959,414		15.2	922.0	13.6	3.05	0.00E+00	6.82E-01	0.00E+00	0.00E+00
MC8604A	Conveyor Vent 1	315,157	1,958,214	9.3	13.7	310.8	5.2	0.60	0.00E+00	0.00E+00	3.01E-04	1.50E-04
MC8604B	Conveyor Vent 2	315,093	1,958,177	9.3	28.1	310.8	5.2	0.60	0.00E+00	0.00E+00	3.01E-04	1.50E-04
MC8604C	Conveyor Vent 3	315,028	1,958,141	9.5	37.9	310.8	5.2	0.60	0.00E+00	0.00E+00	3.01E-04	1.50E-04
MC8606A	Conveyor Vent 4	314,989	1,958,085	9.5	43.7	310.8	5.2	0.60	0.00E+00	0.00E+00	1.64E-04	8.20E-05
MC8606B	Conveyor Vent 5	315,008	1,958,049	9.5	43.7	310.8	5.2	0.60	0.00E+00	0.00E+00	1.64E-04	8.20E-05
MC8609	Conveyor Vent 6	314,967	1,958,034	9.5	5.6	299.7	5.2	0.60	0.00E+00	0.00E+00	2.84E-04	1.42E-04
MC8610	Conveyor Vent 11	314,996	1,957,976	9.5	5.6	299.7	5.2	0.60	0.00E+00	0.00E+00	2.67E-04	1.33E-04
MC8611A	Conveyor Vent 7	315,022	1,957,961	9.5	9.9	299.7	5.2	0.60	0.00E+00	0.00E+00	3.59E-04	1.79E-04
MC8611B	Conveyor Vent 8	315,034	1,957,864	9.5	8.9	299.7	5.2	0.60	0.00E+00	0.00E+00	3.59E-04	1.79E-04
MC8611C	Conveyor Vent 9	315,047	1,957,753	9.5	14.5	299.7	5.2	0.60	0.00E+00	0.00E+00	3.59E-04	1.79E-04
MC8611D	Conveyor Vent 10	315,057	1,957,669	7.9	18.9	299.7	5.2	0.60	0.00E+00	0.00E+00	3.59E-04	1.79E-04
SL8601B	Ship loader1	314,998	1,957,656	7.3	9.1	299.7	5.2	0.60	0.00E+00	0.00E+00	2.47E-04	1.23E-04
SL8601C	Ship loader2	315,014	1,957,576	9.3	9.1	299.7	5.2	0.60	0.00E+00	0.00E+00	2.47E-04	1.23E-04
SL8601A	Load Arm	315,063	1,957,630	9.3	18.9	299.7	6.5	0.60	0.00E+00	0.00E+00	3.42E-02	1.71E-02
B8601	Dome1	314,981	1,958,105	9.5	38.1	299.7	0.001 *	1.20	0.00E+00	0.00E+00	7.08E-04	3.54E-04
B8602	Dome2	315,019	1,958,027	9.5	38.1	299.7	0.001 *	1.20	0.00E+00	0.00E+00	7.08E-04	3.54E-04
COKEV1	Coke vent 1	315,164	1,958,275	8.5	55.0	373.2	0.001 *	0.30	0.00E+00	0.00E+00	1.75E-01	8.73E-02
COKEV2	Coke vent 2	315,167	1,958,276	8.5	55.0	373.2	0.001 *	0.30	0.00E+00	0.00E+00	1.75E-01	8.73E-02
COKEV3	Coke vent 3	315,197	1,958,286	8.5	55.0	373.2	0.001 *	0.30	0.00E+00	0.00E+00	1.75E-01	8.73E-02
COKEV4	Coke vent 4	315,199	1,958,286	8.5	55.0	373.2	0.001 *	0.30	0.00E+00	0.00E+00	1.75E-01	8.73E-02

Limetree Bay EJ Analysis - Emissions and Stack Parameters - Point Sources												
Source ID	Source Description	Easting (X)	Northing (Y)	Base Elev.	Stack Ht	Temp.	Exit Vel.	Stack Dia.	SO2	NO2	24hr PM25	Ann PM-25
		(m)	(m)	(m)	(m)	(K)	(m/s)	(m)	(g/s)	(g/s)	(g/s)	(g/s)
STKPITA	West Sulfur Pit Vent 1	313,295	1,958,811	11.6	9.1	405.0	0.9	0.30	0.00E+00	0.00E+00	4.63E-02	2.32E-02
STKPITB	West Sulfur Pit Vent 2	313,294	1,958,814	11.6	9.1	405.0	0.9	0.30	0.00E+00	0.00E+00	4.63E-02	2.32E-02
STK3SRU	East Sulfur Pit Vent 1 SRU3	314,723	1,959,025	8.5	12.2	405.0	1.2	0.30	0.00E+00	0.00E+00	2.90E-02	1.45E-02
STK4SRU	East Sulfur Pit Vent 2 SRU4	314,727	1,959,009	8.5	12.2	405.0	1.4	0.30	0.00E+00	0.00E+00	3.39E-02	1.70E-02
Note: Sources with an exit velocity listed as 0.001 were modeled as horizontal exhausts in AERMOD.												

Limetree Bay EJ Analysis - Emissions and Release Parameters - Material Handling Volume Sources

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elev (m)	Release Ht (m)	Init. Horizontal (m)	Initial Vert. (m)	24-hr PM25 (g/s)	Ann PM-25 (g/s)
ESS	East Sulfur Storage	314,786.4	1,958,948.5	8.5	3.0	11.6	0.9	0.0577	0.0289
WSS	West Sulfur Storage	313,365.2	1,958,750.3	11.6	3.0	11.6	0.9	0.0324	0.0162
SSB	Sulfur storage basin	314,565.4	1,958,100.6	8.5	3.0	11.6	0.9	0.0977	0.0488
CDRUM	Coke Drum Drop	315,185.5	1,958,274.0	9.3	2.0	1.2	2.3	0.0017	0.0008
CCD	Coke Crusher Drop	315,198.7	1,958,235.5	9.3	3.0	1.2	1.4	0.0632	0.0316
CDS	Coke Drop to Ship	314,993.3	1,957,612.1	0.0	10.0	1.2	1.4	0.0008	0.0004